GENERAL LIBRARY
JUL 1-1920
UNIV. OF MICH.

NATURE

A WEEKLY ILLUSTRATED JOURNAL OF SCIENCE.

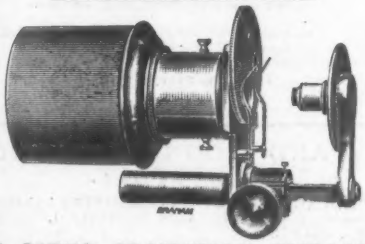
"To the solid ground
Of Nature trusts the mind which builds for aye."—WORDSWORTH.

No. 2642, VOL. 105] THURSDAY, JUNE 17, 1920 [PRICE ONE SHILLING

Registered as a Newspaper at the General Post Office.]

[All Rights Reserved.

OPTICAL PROJECTION APPARATUS
of
EVERY DESCRIPTION.



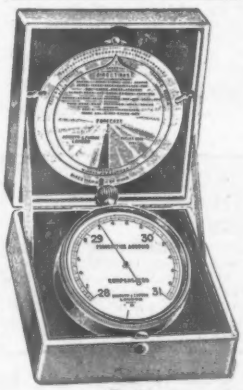
LOW POWER PROJECTION MICROSCOPE
for attaching to any Optical Lantern.

NEWTON & CO.
(*late of* 3 *Fleet Street*),
72 WIGMORE STREET, LONDON, W. 1.

CHEMICALS
Analytical, Technical and A.R.
REGD. TRADE MARK **APPARATUS**
Balances
BENCHES
Fume Chambers, etc.,
for
A SNOW CRYSTAL **Chemical Laboratories**
Price Lists and Estimates on Application.

REYNOLDS & BRANSON, LTD.,
Contractors to the War Office, Admiralty, and Egyptian Government, &c.,
14 COMMERCIAL STREET, LEEDS.

DUROGLASS LTD.
14 CROSS STREET, HATTON GARDEN, E.C.
Manufacturers of
Borosilicate Resistance Glassware.
Beakers. Flasks, Etc.
Soft Soda Tubing for Lamp Work.
General Chemical and
Scientific Glassware.
Special Glass Apparatus Made to Order.
DUROGLASS WORKS, WALTHAMSTOW.
AGENTS:
BAIRD & TATLOCK (LONDON) LTD.
14 CROSS ST., HATTON GARDEN, E.C. 1.



New Patent Weather Forecaster

Enables the weather to be accurately determined for the next 12 hours.

Descriptive Leaflet sent on request.

NEGRETTI & ZAMBRA
38, HOLBORN VIADUCT, E.C.1.
5, LEADENHALL ST. E.C.3.
122, REGENT STREET, W.1.

UNIVERSITY OF LONDON.

A Course of Two Advanced Lectures in CHEMISTRY, entitled 1) "EMPLOI DES MÉTAUX AMMONIUMS EN CHIMIE ORGANIQUE," (2) "L'ŒUVRE SCIENTIFIQUE D'HENRI MOISSAN," will be given by Monsieur P. LEBEAU (Professeur à l'Ecole Supérieure de Pharmacie, Université de Paris) at King's College, Strand, W.C., at 5 p.m. on June 28 and 30. Chairman at first lecture: Prof. F. G. DONNAN, C.B.E., F.R.S.; Chairman at second lecture: Prof. Sir WILLIAM TILDEN, F.R.S. The lectures, which will be delivered in French, are open to the public without fee or ticket. Syllabus obtainable on application.

P. J. HARTOG,
Academic Registrar.

UNIVERSITY OF EDINBURGH.

FACULTIES OF ARTS AND SCIENCE.

ACADEMICAL YEAR 1920–21.

NOTICE is hereby given that all students who wish to attend First Year Science subjects, whether in the Faculty of Science or in the Faculty of Arts must enter their names and intimate the subjects not later than July 1.

WILLIAM WILSON.
Secretary to the University.

NEWCASTLE-UPON-TYNE EDUCATION COMMITTEE.

RUTHERFORD TECHNICAL COLLEGE.

Principal—C. L. ECLAIR-HEATH, Esq., Wh.Sc., A.M.I.M.E.

The College Council invite applications for the following additional appointments; duties to commence early in September, 1920:—

	Commencing Salary.	Max. Salary.
(*a*) ONE HEAD of ENGINEERING DEPT.	£500 ...	£650
(*b*) TWO ASSISTANT LECTURERS in ENGINEERING	300 ...	450
(*c*) ONE ASSISTANT LECTURER in ELECTRICAL ENGINEERING ...	300 ...	450
(*d*) ONE HEAD of PHYSICS and MATHEMATICS DEPT.	400 ...	550
(*e*) ONE ASSISTANT, PHYSICS and MATHEMATICS DEPT.	300 ...	450
(*f*) ONE LECTURER in PHARMACY (fixed)	350 ...	—
(*g*) ONE ASSISTANT LECTURER in CHEMISTRY	250–300* ...	400
(*h*) ONE GENERAL ASSISTANT ...	250–300* ...	400

* According to qualifications and experience.

In the case of (*a*), (*b*) and (*c*) candidates must have had a good University or technical education and training, works and drawing office experience, and the equivalent to a degree. Some teaching experience preferred.

In (*a*) the candidates should have a good experience also in marine engineering.

In (*d*), (*e*) and (*g*) candidates should have a good scientific education, a University degree, some teaching experience with technical students, and knowledge of the applications of their subjects to industry.

In (*h*) it is essential that candidates should have good qualifications for teaching English to technical students, and preference will be given to those having a Science Degree.

In (*f*) candidates should have passed the Major Examination of the Pharmaceutical Society, had good experience in General Pharmacy and Chemistry, be able to teach Botany, and assist with Chemistry.

Forms of application (which may be obtained by sending stamped addressed foolscap envelope to the undersigned) must be returned by Thursday, June 26, 1920, to

THOS. WALLING,
Director of Education.

Education Offices,
Northumberland Road.
H/W.

UNIVERSITY COLLEGE, NOTTINGHAM.

MINING DEPARTMENT.

Applications are invited for the position of LECTURER in COLLIERY ENGINEERING, whose duties will involve lecturing to Mining students on Mechanics steam, compressed air and general power distribution. Preference will be given to candidates who have had practical experience in the manufacture and installation of colliery plant. Salary £400.

Further particulars and forms of application, which must be returned by June 30, may be obtained from the REGISTRAR.

UNIVERSITY COLLEGE, NOTTINGHAM.

MINING DEPARTMENT.

Applications are invited for the position of LECTURER in FUELS and OILS, who will also be required to undertake lectures in general elementary chemistry, mine gases, explosions, gob fires, and coal carbonisation to Mining students. Salary, £400.

Further particulars and forms of application, which must be returned by June 30, may be obtained from the REGISTRAR.

ROYAL NAVY.

Applications are invited for appointments as SCHOOLMASTERS to carry on the Higher Education of Men and Boys of the Royal Navy.

Applicants should have had experience in teaching, preferably in Technical or Secondary Schools, and must be medically fit.

Selected candidates will enter as Acting Warrant Officers and be given a Preliminary Course of training lasting six months; this will be followed by six months' probation, after which they will be confirmed in Warrant Rank. Commissioned Rank will be given 19½ years later. Schoolmasters showing special ability will be eligible for selection for special promotion after 8 years' service to Commissioned Rank, and thence to the equivalent rank of Lieutenant and Lieutenant Commander.

During the Preliminary Course Candidates will be paid 9*s.* 6*d.* per day, and during the probationary period 10*s.* 6*d.* per day. Afterwards payment will be according to the following scales, the increments being triennial:—

Title.	Rank.	Pay per annum.
SCHOOLMASTER	... Warrant Officer	...£200 15*s.*–£18 5*s.*–£310 5*s.*
SCHOOLMASTER or SENIOR MASTER	Commissioned Officer from Warrant Rank	£346 15*s.*–£36 10*s.*–£456 5*s.*
HEADMASTER	... Lieutenant ...	£492 15*s.*–£18 5*s.*–£529 5*s.*
HEADMASTER after 8 years	Lieutenant Commander	£565 15*s.*

Officers of the Schoolmaster Branch (including Candidates taking the Preliminary Course) are entitled to accommodation and rations, or to receive compensation in lieu (amounting at present to £140 per annum); also to outfit allowances of £20 on entry, £20 at end of first year, and £50 on promotion to Lieutenant; and to medical attendance. Schoolmasters are entitled to pensions if retired after 20½ years' service, or at any time if invalided; if they retire with less than 20½ years' service they receive gratuities only; the maximum pensions being for Warrant Officer £180, Commissioned Officer from Warrant rank £250, Lieutenant £300, Lieutenant Commander £350.

All rates of pay and retired pay are liable to review in 1924 in the light of the cost of living, and thereafter every three years, on the basis of Board of Trade food prices.

There are also pensions for widows and compassionate allowances for children (according to the rank of the Officer).

For further particulars apply to

THE SECRETARY OF THE ADMIRALTY,
Whitehall,
London, S.W. 1.

CITY AND COUNTY BOROUGH OF BELFAST.

The TECHNICAL INSTRUCTION COMMITTEE invite applications for the following POSITIONS in the MUNICIPAL TECHNICAL INSTITUTE, BELFAST.

LECTURER and DEMONSTRATOR in MECHANICAL ENGINEERING, Remuneration £350 per annum, including Bonus, rising to £420 per annum. (It is essential that applicants for this position should have a University Degree in Science or Engineering.)

ASSISTANT LECTURER and DEMONSTRATOR in MECHANICAL ENGINEERING. Remuneration £320 per annum, including Bonus, rising to £370 per annum.

TWO ASSISTANT LECTURERS and DEMONSTRATORS in PHYSICS and ELECTRICAL ENGINEERING. Remuneration for each Assistant, £320 per annum, including Bonus, rising to £370 per annum.

Particulars of the duties and conditions of appointment may be obtained from the undersigned, with whom applications, on the Special Form provided for the purpose, must be lodged not later than Noon on *Tuesday, June* 29, 1920.

Applications should be accompanied by copies o three recent testimonials (original testimonials must not be sent).

Canvassing is Strictly Forbidden and will Disqualify.

RUPERT STANLEY, Principal.

Municipal Technical Institute,
Belfast.

DARLINGTON EDUCATION COMMITTEE.

TECHNICAL COLLEGE.

Principal—R. M. CAVEN, D.Sc.

Applications are invited for the following posts:—

(*a*) HEAD of the DEPARTMENT of ELECTRICAL ENGINEERING, PHYSICS and PURE MATHEMATICS. Commencing salary £350 per annum, rising by annual increments of £12 10*s.* to £400. Applicants are required to be Graduates of British Universities.

(*b*) ASSISTANT LECTURER in ENGINEERING. Commencing salary £300, rising by annual increments of £12 10*s.* to £350. Preference will be given to Graduates of British Universities with Practical Engineering experience.

Further particulars and Forms of Application may be obtained from the undersigned, to whom completed forms should be returned not later than July 14, 1920.

A. C. BOYDE,
Director of Education and Secretary.

June, 1920.

THURSDAY, JUNE 17, 1920.

Editorial and Publishing Offices:
MACMILLAN & CO., LTD.,
ST. MARTIN'S STREET, LONDON, W.C.2.

Advertisements and business letters should be addressed to the Publishers.
Editorial communications to the Editor.

Telegraphic Address: PHUSIS, LONDON.
Telephone Number: GERRARD 8830.

University Stipends and Pensions.

NO one disputes that "there is no organised intellectual unit higher or more comprehensive than a University," and few, on reflection, would differ from Sir John Seeley in affirming that the education in England is what the Universities choose to make it. Not only are the Universities and institutions of University rank the highest product of our educational system, but they also have the power of influencing the trend of thought and ideals in education to an incalculable degree. To a large extent, therefore, the advance to a higher plane of civilisation is dependent upon their free and untrammelled development. In pursuit of truth, whether in philosophy, or science, or technology, independent of material considerations, they are pioneers of research, blazing the trail for industry, commerce, and those human efforts which add to the sum of life's happiness. Anything which acts as an impediment or hindrance to this development cannot be viewed simply as an injury to the institutions themselves; it is an injury to the community, to the nation, and to civilisation. If this be true, one or two facts of capital importance require to be considered in the light of a few principles. For the moment, however, let us examine the broad relations of the State to the University.

The State can no more dispense with the co-operation of the Universities than the Universities with the co-operation and assistance of the State. Their interests are mutual and their services reciprocal. The influence of the University ramifies through the whole of the administration of the country, its great Departments of State and its two legislative Houses, its local governing bodies and its courts of justice. Obviously the State cannot afford to see the Universities or the University colleges wilt under economic pressure. Now this is precisely what will happen if it does not take a clearer view of its responsibilities and their logical implications. The University grant, demonstrably insufficient in pre-war times, is absurdly inadequate now. Not merely have money values changed to an extraordinary extent, but the demands upon the Universities in regard to accommodation, equipment, and facilities for research have increased to an almost equal degree. If to these be added the necessary adjustments in salaries of the staffs, the inadequacy is still more apparent.

The State will have to recognise these facts and, if for no other reason than that of enlightened self-interest, to assume heavier financial responsibilities. As matters stand at present, those borne by the State are altogether disproportionate to the services rendered by the Universities to the nation. In consequence, the statement is as true to-day as it was when made ten years ago that our newer Universities are "a composite figure in which progress and poverty are the prevailing hues." But such increased financial responsibility should not absolve the State from preserving in its traditional integrity that freedom which is the life-blood of an institution coeval in origin with Parliament itself. It is platitudinous to say that no one wishes to see the Universities, new or old, in any sort of intellectual subjection. Unfortunately, however, intellectual subjection is too often the outcome of material subjection. A wise State will show its wisdom in preserving in all its integrity that from which it derives, indirectly though it be, its vital energy, and through which it renews its spiritual life from generation to generation.

On broad and general grounds we have argued that the State has responsibilities to the institutions of higher learning of which it cannot divest itself, and that these responsibilities are such as can be fulfilled only by much more generous financial support than is given at present. It is necessary, therefore, to indicate how seriously these institutions are affected by the lack of this support. The question of stipends and pensions alone will be considered. Too often a university is conceived in terms of stone and mortar; essentially, however, it is a corporation, a society of human beings, a body of teachers and students. To say that an efficient and highly qualified staff is fundamental is simply to express a truism. Such a staff is the product of many years of patient and unremitting study. If by any mischance or lack of vision the flow of able and gifted students to this higher teaching is checked, the loss will be irreparable. That such a result

is not a remote possibility is becoming sufficiently obvious to those who are watching the present trend of University affairs. A teacher does not enter on his career in the hope of amassing riches. With such an ambition the teaching profession is among the last to which he would resort. Debarred from the financial prizes possible to a business career, he has the right to expect emoluments which will enable him to live decently and to move in a social circle to which his education and training entitle him. This is especially true of the University teacher.

Now, as a matter of fact, the stipends of University teachers in this country at the present time, particularly in the non-professorial staff, do not conform to this standard, but fall miserably short of it. A large proportion of assistant lecturers and demonstrators, full-time teachers, receive no more, and some much less, than 250*l.* a year—a salary or wage which, under present conditions, would be accepted by no self-respecting mason or miner. The grade of lecturer, comprising as it does a great number of men and women who can never hope to attain professorial rank, however well qualified for it by ability and experience, fares little better. The average salary of this class ranks somewhere near 400*l.* a year, and one may take it that the pre-war value of this sum is approximately equal to 200*l.* a year. If the average rate of remuneration of such posts remains at these figures, it requires no gift of prophecy to predict that the flow of talent to the teaching staffs of the Universities and University colleges will inevitably be checked.

The question of the remuneration of the non-professorial element is most important. The numbers are great, the aggregate hardships intolerable. But the stipends of professors as a whole also show little relation to the emoluments in corresponding positions outside the University. A large number of professors receive less than 800*l.* a year, and considerably more than 80 per cent. less than the professorial salary indicated by the Association of University Teachers as a minimum—viz. 1100*l.* a year. Obviously, again, the gift of prophecy need not be conjured up to predict the result. Already the professorial ranks have been, and are being, depleted by the superior inducements offered in industrial, scientific, and commercial business organisations. It is futile to argue that public benefactions should make good these pressing needs. One cannot dragoon public benefactions. It is too much to expect the local authorities and the students to make good the deficiencies. Generally speaking, both contribute reasonable proportions. The matter is a State affair, and the State must implement to the full its responsibilities.

The present position regarding superannuation is very unsatisfactory. As a general principle, it may be laid down that anything which restricts the field from which the University recruits its staff is inimical to University interests, and hence, in the long run, to education in general. Now the effect of the School Teachers (Superannuation) Act, 1918, is to restrict this field. Any school teacher eligible for its benefits cannot accept an appointment in a University without sacrificing pension rights, in whole or in part. Thus it interposes a barrier—in some cases insurmountable—between the University on one hand, and the technical colleges, the training colleges outside the University, and the schools on the other. The free transfer of teachers to the University is hampered. Already cases are on record of candidates refusing University appointments on finding that acceptance would entail a loss of pension benefits accruing from the Act. It would be most unfortunate if service in schools—a most useful experience for a future University teacher—is to be a bar to later service in the University.

Another effect of the Act is to draw an invidious distinction between existing University teachers and other teachers. Ninety-five per cent. of the whole teaching profession are now eligible for pension benefits incomparably superior to any previous teachers' scheme; while 5 per cent., the University teachers, are excluded, and excluded without any compensation. The position is illogical, unjustifiable, and detrimental to education. One or two illustrations will make this clear. In the University of London some schools of the University come within the provisions of the Act; the rest do not. Thus transfers from one school to another within the same University are made difficult or even impossible. The principal of the Government School of Art attached to a certain University college is said to be the only principal of such a school who is not qualified under the Act—this solely because his school forms part of the University college. In other districts neighbouring institutions engaged in the training of teachers are distinguished from one another in the matter of superannuation, because one forms a department of a University and the other does not. This is in spite of the fact that the two institutions are doing the same kind of work, for the same purpose, under the same authority (the

Board of Education), and that their students do their teaching practice in the same kind of schools under the same local education authority. These facts would be highly diverting were their consequences not so serious.

This anomalous state of affairs has provoked much criticism in University circles. What complicates matters is the fact that there exists a contributory pension scheme in the Universities—the federated superannuation scheme—which is thought by some to be superior to the Teachers Act in certain respects, such as in cases of death during service and of retirement before the age of sixty, and in the form of benefit on retiral. As against these the Teachers Act is non-contributory, it is retrospective, and its benefits are calculated upon the average salary in the last five years of service. The whole question has been considered by a conference of representatives from the Universities of England and Wales, at which it was unanimously resolved to lay the case before the Chancellor of the Exchequer in terms of the following resolutions :—

"(1) That this Conference is of opinion that the interests of English and Welsh education as a whole demand the institution of a scheme of superannuation for University teachers and administrative officials conferring benefits not inferior to those granted under the School Teachers (Superannuation) Act, 1918, and of a like retrospective character; (2) that such a scheme should make due provision (*a*) for the superannuation of persons who enter the service of a University or University college so late in life as to be unable to acquire the service qualification necessary under the School Teachers Act; (*b*) for meeting the case of persons who retire before the normal age of retirement; and (*c*) for meeting the case of persons who die on service. (3) That any scheme of superannuation for University teachers and administrative officials should be of such a nature as to allow (without loss in respect of superannuation) the transfer of a person employed at a University or University college to another approved educational or scientific institution in Great Britain or *vice versa*."

The term "institution," of course, includes schools. These resolutions have been accepted by the Association of University Teachers. Whatever be the result, it is a great step forward to have secured unanimity on essentials. The resolutions have clearly demonstrated the present absolute inadequacy of the federated superannuation system and the difficulty of patching up its deficiencies as regards retrospective benefits, interchangeability of teachers, and the amount of retiral allowances or annuities.

Aerography.

The Principles of Aërography. By Prof A. McAdie. Pp. xii+318. (London: G. G. Harrap and Co., Ltd., 1917.) Price 21*s.* net.

FROM time to time it has been a subject of remark by the learned that a book on meteorology has to be a collection of essays, because the available material does not lend itself to exposition in a connected treatise. The substitution of the new name aerography for the older meteorology has not changed the leopard's spots. Indeed, Prof. McAdie has made the peculiarities of the subject more remarkable by presenting a work which is partly a collection of meteorological essays, and partly the note-book of a physicist interested in the study of the atmosphere.

Out of eighteen chapters, the first four are a recitation of the physical meteorologist's "credo," which includes absolute units as a theme with variations, preceded by a brief history. There follow nine chapters, which are partly note-book and partly essay; then the essay gradually extends its claim in chapters on atmospheric electricity, precipitation, floods, and notable storms, until it fully asserts itself in a chapter on frosts. Finally, a couple of pages of solar influences lead us to an appendix of conversion-tables and an excellent index.

It is the characteristic of the note-book which will appeal most to the reader. We find a summary of references to the results of modern aerological research which are frequently wanted and not elsewhere at hand. Very useful information about investigations with kites, pilot balloons, and sounding balloons is put in an attractive form. It includes, on p. 19, a table of extreme elevations reached by various means, and much other information of like character. The whole is well illustrated by photographs, maps, and diagrams. It is rather discursive. It begins with the troposphere and stratosphere; winds follow the "major circulation" and the "minor circulation." Ocean currents get a "look in" with the major circulation.

The "credo" is interesting; it shows how careful one has to be in choosing words to express one's meaning. The student has to think when he reads: "The gas constant for the air is not constant. It varies . . . owing to the non-adiabatic character of the atmosphere." "It should be remembered that a gram of ice is by weight a little more than a cubic centimetre, and if pure ice is used only 73 calories are needed" (for liquefaction). Very little unorthodoxy is

allowed to escape through the meshes of the author's critical net, but he is apparently not concerned with the prevalent yet distracting use of the word "gradient" to mean rate of loss per unit length either in the vertical or horizontal direction when speaking of temperature. In this country we are becoming accustomed to confine the word "gradient" to what is commonly understood when it is used with pressure, and to use "lapse" for vertical changes, which are normally losses, with increasing height.

As readers of NATURE already know, it is part of Prof. McAdie's "credo" that pressure should be expressed in "kilobars," which are now commonly known as "millibars," and that temperature should be expressed in new absolute units of which 1000 go to 273 degrees of the Centigrade scale. In the reviewer's experience of units the whole world is divided into three very unequal parts. By far the largest part is made up of persons who think that absolute units for practical concerns are obviously impossible because the man in the street does not "understand" them at all; the next largest of those who think that absolute units in practice are quite unnecessary because any competent man of science fully understands them and can make the transition whenever he requires them; and the third is a small body of persons who are devoted to their use because the scientific future of meteorology lies that way. To change once more the already changed in order to remove an apparent historical inconsistency conveys no promise of ranging the well-informed minority on the side of progressive action, but would hand us over helpless to the judgment of the great majority who do not "understand," and who are obsessed with the idea that scientific results are naught if they cannot be used without thinking.

Among the excellent illustrations of the book are some photographs of cloud-forms. Its author is very insistent that Luke Howard's classification of cloud-forms on the basis of appearance, as extended by the international conferences, is wrong in principle. He thinks they should be classified according to origin. Unfortunately, the appearance is all that an observer can record, and to ask the ordinary observer to differentiate between similar appearances according to some general instruction as to origin would add materially to the difficulties of the student. What is most wanted is some effective means for the individual observer to ascertain the height of the cloud which he sees. Some simple form of range-finder for clouds suitable for the chief observatories ought not to be beyond the limit of possibility.

The book comes from Blue Hill Observatory, now a part of Harvard University, and contains much incidental information as to the great services which that establishment has rendered to meteorology. Its many friends and admirers in this country will welcome the attempt of its present chief to set out the leading principles of aerography which the observatory has done so much to elucidate.

Paper-making and its Machinery.

Paper-making and its Machinery: Including Chapters on the Tub-sizing of Paper, the Coating and Finishing of Art Paper, and the Coating of Photographic Paper. By T. W. Chalmers. (The *Engineer* Series.) Pp. xi+178+vi plates. (London: Constable and Co., Ltd., 1920.) Price 26*s*. net.

THE author in his preface has rightly stated that the chemist interested in paper-making finds ample technical literature at his disposal, whereas the engineer is not provided with any books dealing with the peculiar mechanical problems of his industry. Since the publication of Hofmann's treatise on "The Manufacture of Paper" in 1873 no serious attempt has been made to supply the paper-maker with an intelligent and comprehensive text-book devoted to a study of the economic and efficient control of the machinery peculiar to the manufacture of paper.

Mr. Chalmers's effort in this direction, admirable as it is, regarded in its proper aspect as a pioneer to some such technical treatise, falls far short of our expectations in this direction. It is doubtful whether a really practical and useful text-book on the engineering problems of the paper industry will ever be written. The utility of the book we have in mind will depend on a free and frank *exposé*, by an engineer thoroughly acquainted with the art and practice of paper-making, of conditions, methods, economics, power costs, capacities, output, means for overcoming difficulties, and the hundred "wrinkles" born of long apprenticeship. The description of paper-machines and subsidiary appliances, essential as it certainly is, constitutes only one part, and that the minor part, of an ideal manual.

The causes which have contributed to this lack of information may be traced to the somewhat natural reluctance on the part of a practical engineer to "give away" his knowledge. Every engineer fondly believes he has a monopoly of this kind, and the difficulty of shaking him from such an idea may fully account for the absence of a text-book which would be gladly welcomed by the trade. We may therefore reasonably hope that the present work will inspire some paper-maker to write a supplement.

Mr. Chalmers has done good service in showing that the processes involved are so many as to justify the issue of a book giving detailed descriptions of the special machinery.

After a brief introductory chapter dealing with sundry historical facts the author proceeds to classify the machinery and apparatus under the several processes of manufacture, beginning with rag-choppers and dusters, as required for cleaning material preparatory to chemical treatment. The well-known types of cutters and dusters are clearly illustrated.

The section devoted to the boiling of fibrous material is incomplete owing to the omission of multiple-effect evaporators, the rotary incinerator furnace, causticising pans, and the plant necessary for the recovery and causticising of spent liquors. This is to be regretted.

The processes for washing, breaking, and bleaching the boiled materials are next described, being accompanied by drawings of machinery in common use. Masson and Scott's bleaching-tower system is shown as dependent for its efficiency on the continual circulation of bleached stock. Experience has proved that intermittent circulation gives good results with economy in power. Plant used for pulping is well represented by the Kollergang and various kneading machines.

The important and difficult subject of beating is fairly handled, the temptation to describe "freak" beating engines being avoided. The merits of beaters with separate circulating devices are discussed, and the special functions of refiners clearly described. The value of this section of the book would have been greatly enhanced by the inclusion of precise details as to power consumption, capacity, output, and costs of maintenance. The author appears to have confined his attention to the description and illustrations of the machinery.

Chaps. vii. to xi. are devoted to the production of an endless sheet of paper, and give an excellent account of the Fourdrinier machine used for this purpose. The illustrations are mainly produced from the machine in operation at the *Daily Telegraph* paper-mills, Dartford.

The wear-and-tear of the machine wire is amply shown by the statement that the load on a 100-in. machine wire may be 1½ tons, due to the vacuum at the suction-boxes. No reference is made to the much-advertised suction-roll which came into prominence some years ago.

The importance of a stuff-catcher, or economiser, for saving the fine fibres and loading in the backwater is referred to, and Füllner's save-all stands as the typical machine for the purpose. This appliance is now almost entirely superseded by the vat-mould type of save-all with large, hollow cylinder and endless felt.

The many designs of pulp-strainers are fully illustrated, from the original flat type of early days to the circular, oscillating forms of modern times. The finishing processes of paper-making are illustrated by tub-sizing machines, calenders, and cutters.

Chap. xiv. is devoted to a description of wood-pulp and its manufacture, necessarily brief because very little wood-pulp is made in this country. Only one or two mills are seriously occupied with its manufacture.

The two most interesting chapters in the book are those dealing with "The Coating of Art Paper" and "The Coating of Photographic Paper." The author is probably correct, so far as our memory serves us, in saying that the information given in this connection is in many respects quite new, and much fuller than any previously published.

A full description of a plant for coating art paper, manufactured by Messrs. Mather and Platt, Ltd., is illustrated with excellent drawings and diagrams. It is, of course, well known to our readers that the paper when coated is formed up into long loops, or festoons, which are carried along on endless chains, being gradually dried by warm air. A long room is used for the purpose. In some cases the trackway has to be made longer by bending, so that the festoons can be carried to and fro in a short room. This is effected by the use of "bends" in the trackway, and a complete lay-out of an installation of this kind made by Messrs. Masson, Scott, and Co. is given in the text.

We should not be surprised if many readers interested in paper-making were to obtain a copy of this book on account of the last sections, devoted to the coating of photographic paper. The author rightly emphasises the absolute importance of the body paper, its cleanliness and freedom from iron and metallic particles. The use of baryta, or barium sulphate, is described, and also the special machinery for imparting the sensitised emulsion.

Taking the book as a whole, we are glad to recommend it to those associated with the paper industry. The average engineer of experience may not find much with which he is not already familiar, but to a large class of readers a book of this type must be welcome. It is copiously illustrated by drawings and diagrams, most of which have been supplied or lent by two Scottish engineering firms who understand the value of being obliging and courteous.

R. W. SINDALL.

The Structure of the Nucleus.

Cytology: With Special Reference to the Metazoan Nucleus. By Prof. W. E. Agar. Pp. xii+224. (London: Macmillan and Co., Ltd., 1920.) Price 12s. net.

CYTOLOGY as a science is of relatively recent growth, and its development was made possible only by improvements in the microscope. Yet the study of the details of cell structure and activity is now fundamental to almost every phase of biology. Nevertheless, biologists are too frequently content with a superficial or second-hand acquaintance with this fascinating field.

Previous to 1900 the process of mitosis had been investigated, the general constancy of the chromosomes from one cell generation to another was recognised, and their relations to fertilisation and reduction were understood in a general way, through the studies particularly of Strasburger and Hertwig: the foundations of the present cytology were laid. Synapsis had been recognised by Moore as a unique phase of the nucleus, and this led to a decade of active research by Farmer, Moore, Wilson, Strasburger, Grégoire, and a host of other plant and animal cytologists to elucidate the intricate course of events during the meiotic or reduction period.

But it is during the present century that improvements in method and increasing accuracy of observation have made possible the remarkable series of discoveries which have led to the present outlook on cytological problems. Particularly noteworthy has been the intimate linking up of the chromosomes with the problems of heredity, sex, mutation, and morphogenesis. This era of work began with the discovery of Montgomery in 1901 that the chromosomes in the nuclei of certain animals were in pairs, the members of which are respectively of maternal and paternal origin. Sutton in 1903 clearly established this relationship in an insect in which the chromosomes were of different sizes, and it is now a commonplace of observation in a large number of animals and plants. Several writers had already, shortly before the Mendelian phenomena became known, pointed out the theoretical possibilities for heredity which lie in the reduction division where the pairs of chromosomes are separated to enter different germ-cells. In the following two decades of research, the chain of evidence connecting the chromosomes with heredity and also with variation has drawn ever closer, until now the relationship must be regarded as definitely established.

One of the earlier stages in this proof was the discovery of the sex chromosomes in insects and afterwards in other animals. The initial suggestion of McClung, linking a particular chromosome with sex, was followed by notable discoveries by Wilson, Morgan, Doncaster, and a host of other investigators. Then a constant relationship between chromosome numbers and external characters was shown in the case of the Œnothera mutations; and still more recently the work of Morgan and Bridges on the non-disjunction of chromosomes and its relation to inheritance in Drosophila, combined with an enormous contemporary accumulation of collateral evidence of many kinds, has added the final link in the chain of evidence.

Recent work tends more and more not only to analyse the chromosomes themselves into their visible microscopic elements, but also to show the relationships which these bear to the hereditary Mendelian units. The chromatin morphology in related species is also being compared, and even chromosome phylogeny is no longer a visionary hypothesis.

All these and other recent developments in the field of cytology are admirably set forth in the work before us by Prof. Agar, who has thereby placed all biologists in his debt. The book will be chiefly useful to cytologists as a summary of the facts and the literature connected with a particular field—the nucleus in animals above the Protozoa. Within this purview are discussed many of the problems connected with nuclear structure. The author deals with mitosis and meiosis, syngamy and parthenogenesis, with a detailed discussion of these phenomena in various animal forms. He points out that the fundamental fact of meiosis is the segregation of the members of each pair of homologous chromosomes, and compares the parasynaptic and telosynaptic methods of meiotic pairing. We cannot agree with him that the telosynaptic method has been definitely disposed of, as it is still the best authenticated account in a number of plants and animals. Nor can we find any difficulty in the belief that both methods may exist in different organisms, a view first expressed ten years ago.

The account of meiosis in parthenogenetic eggs is welcome, but the discussion of the germ track in animals might have included a greater variety of forms.

The later chapters give a useful account of the sex chromosomes, theories of chromosome individuality and structure, and variations in chromosome number. An interesting chapter on heredity and morphogenesis considers the chromosome behaviour and sterility in hybrids, the cytological basis of mutation, and general questions

relating to the *rôle* of the nucleus and the chromosomes in development. Another section gives a short account of the chondriosomes, while the final chapter is concerned with the nucleus in the Protista and the nuclear relationships in plants.

The book is well illustrated and excellently produced. While it can scarcely appeal to a wide circle of readers, it will be of great service to all those who wish to be informed concerning the results arising out of the work of the last twenty years on this subject. The cytologist will find it indispensable for reference, and biologists generally will turn to it for the more recent work relating to these problems. R. R. G.

Our Bookshelf.

Aircraft in Peace and the Law. By Dr. J. M. Spaight. Pp. viii+233. (London: Macmillan and Co., Ltd., 1919.) Price 8*s.* 6*d.* net.

THIS is a useful attempt to put before the public the main issues of international law relating to the air. In every new development of modern invention, law-making authorities are faced with the difficult task of applying old principles to developments not contemplated when those principles were formulated, and with such a revolutionary departure as the modern aircraft there is a grave risk of deception by a false analogy. The British method has been to apply as far as possible the principles of the Merchant Shipping Acts to aircraft. The idea is lacking in boldness and imagination, for there is little parallel between the two forms of navigation in relation either to the problems of the navigators themselves, or to the rights and liabilities of the public at large. Generally speaking, however, a wise caution has been exercised by those who framed the International Convention. From another point of view the fundamental issue in aerial navigation is the sovereignty of the air, and on this England reserved her opinion. Continental Powers, without exception, clearly realising the serious military problems before them if all comers were allowed unrestricted flight above their territories, maintained in full their dominion in the air above their lands and territorial waters. England, on the other hand, had a different problem to face. No aerial highway of any importance crosses her frontiers in any part of the world, but nearly all the aerial routes which link up her scattered dominions do almost invariably cross the territories of other nations; she ought, therefore, her aerial experts maintained, to hold out for free flight.

It would seem that this view exaggerated the difficulties put in the way of innocent traffic by the maintenance of sovereignty, and minimised the dangers of sudden invasion. We must not forget that the economic interests of Great Britain are just as dependent on military security as they are on theoretical freedom of transport, and therefore Dr. Spaight would seem to be quite correct in urging the maintenance of the doctrine of the sovereignty of the air. Popular panic is a disaster only less serious than actual assault. The book is well arranged and indexed, while the writer's comments on what is as yet almost an untested department of law of exceptional difficulty, are acute, unprejudiced, and well-informed.

W. B. F.

Wireless Telegraphy and Telephony: First Principles, Present Practice, and Testing. By H. M. Dowsett. Pp. xxxi+331. (London: The Wireless Press, Ltd., 1920.) Price 9*s.*

THE object of this work is to provide a connecting link between the various elementary textbooks, intended for those taking up the study of wireless telegraphy, and advanced treatises dealing with particular aspects or branches of the subject. It does not aim at completeness, but usefully develops certain parts of the theory and practice involved. The author insists upon an adequate appreciation of the structure of the atom and the part played by its constituents for a clear understanding of the phenomena met with in wireless working, and puts forward conceptions which, if not presenting a perfectly true scale model of the atom, at any rate are helpful in fixing the ideas. Another theoretical chapter leads up to explanations of some of the methods used in spark and continuous-wave transmission; and perhaps the most important sections of the book deal with the thermo-ionic valve and the modern methods of its employment for both reception and transmission, upon which so much of the recent advances depends. Other developments dealt with are high-speed automatic transmission and direction finding. A considerable portion of the book is devoted to systems of measurement of electrical quantities adapted to wireless telegraph testing. The author concerns himself only with up-to-date methods, and historical matter does not form part of his scheme.

Chimica delle Sostanze Esplosive. By Prof. Michele Giua. Pp. xvi+557. (Milano: Ulrico Hoepli, 1919.) Price 28 lire.

THIS treatise is written from the point of view of the laboratory chemist, and contains a very full account of the chemistry of explosive compounds. The author bases his work on that of Berthelot, and develops the theoretical treatment of explosive reactions on thermochemical lines. When dealing with the propagation of explosions through gases, the work of British investigators is practically unnoticed, and although a few references to papers do indeed appear in a table, they are omitted from the index. The treatment of this part of the subject thus appears to be rather superficial. The explosive compounds are described fully, and brief, but clear, accounts are given of the plant used in their manufacture. This section, with its numerous references to the litera-

ture, should prove of value to the organic chemist, but there is little attempt to compare the relative advantages of the compounds so described as constituents of technical explosives, and a comprehensive review of the whole subject is lacking. A later section contains the compositions of a large number of explosive mixtures, drawn mainly from the patent literature. It may be noted that, whilst many complex mixtures containing ammonium nitrate as their principal constituent are cited, there is no mention of the simple amatol mixtures which were so extensively employed during the war. The closing chapter describes the usual methods of testing explosives, and of performing the analysis of the raw materials and finished products. The illustrations include numerous photomicrographs of crystalline compounds, nitrated fibres, and prepared mixtures.

C. H. D.

Lad: A Dog. By Albert Payson Terhune. Pp. 309. (London and Toronto: J. M. Dent and Sons, Ltd., 1920.) Price 6*s.* net.

THOSE who like dogs will find this tribute very interesting, and will, we think, be able to confirm much of it from personal experience. Those who begin the book with a prejudice in the other direction are, we think, likely to change their position. The story is told enthusiastically, but there is no nonsense about it, and the anthropomorphism is restrained. Some comparative psychologists of the severer sort have said that the fatal thing is a personal interest in the creature observed, and the danger of mingling emotion with inference, and inference with observation, is well known. We might admit this, and yet hold that comparative psychology is likely to be advanced by intimate studies such as Mr. Terhune has given us of "Lad." There may be glimpses of reality to be got in this way which the analytic method does not reveal. In any case, the author has told, in a very delightful way, the story of a charming companion endowed with considerable complexity of character which nurture enhanced. For "Lad" was a "real" dog, and the chief happenings in nearly all the stories about him are "absolutely true." He lived out a full span of sixteen years, and his epitaph reads "Thoroughbred in Body and Soul."

A Theory of the Mechanism of Survival: The Fourth Dimension and its Applications. By W. Whately Smith. Pp. xi+196. (London: Kegan Paul, Trench, Trubner, and Co., Ltd.; New York: E. P. Dutton and Co., 1920.) Price 5*s.* net.

THERE is nothing striking or new in this argument, neither is there anything extravagant in its application. The author expounds in a clear and easy manner the familiar notions of flatland and of a possible fourth dimension, and suggests that a hypothesis is necessary to explain the somewhat doubtful phenomena with which psychical research deals. These notions, he thinks, afford the basis of a hypothesis.

Letters to the Editor.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

London University Site and Needs.

I HAVE been surprised that no word of protest has been raised against the scheme of locating the University of London on a limited plot of land in the centre of the city. If the site were for administration purposes alone, combined, perhaps, with lecture-rooms for those subjects which require no practical instruction, the area offered might be adequate, but could only be rendered suitable for its purpose at such an enormous cost for site, removal of existing buildings, and erection of new edifices, that nothing but the most urgent necessity could justify; nor would the new position be one whit better or more convenient than South Kensington. It is, however, understood that the buildings to be erected are not only for administration purposes and lectures, but also to meet all requirements of the scientific departments.

Now it can be easily shown that provision for scientific subjects will require a far greater area of land than the amount suggested in the Government's offer. For the population of London one thousand would be a moderate estimate for the number of students who might be expected to need instruction in any one of the great departments of science, of which not fewer than twenty would need to be provided. Taking into consideration passages, staircases, preparation rooms, and assistants' rooms, for every working place in any practical department a floor area of at least ten square yards is wanted. Therefore, for each of the twenty subjects not less than ten thousand square yards of floor-space would be necessary. In addition to this, each will require lecture theatres, demonstration rooms, and research rooms; and for this, on a moderate estimate, we must add 50 per cent. to the above figure. This gives a total requirement for the twenty practical departments of not less than fifty acres of floor-space, in addition to the area wanted for administration purposes, libraries, museums, and for the subjects which do not need accommodation for practical work. Unless, therefore, the "skyscraper" system is to be utilised for university buildings, the 11½-acre plot proposed to be given up for the purposes of the University of London is absurdly inadequate, especially since not more than 8 acres of such a site could possibly be covered by actual buildings.

The problem is, however, much more complex than is represented by a mere computation of floor area. Anyone who has experience of a practical department knows the supreme importance of placing it in an entirely separate, self-contained building or institute, thereby allowing abundance of light for all rooms and furnishing space for any necessary future extension. Such institutes cannot be erected on a limited site. They require far more land than can ever be provided in the centre of a town. It is, therefore, certain that a single university adequate for the needs of London cannot be established in the situation proposed by the Government; and it is not too much to assert that its purchase and the cost of erecting buildings upon it would be a most wasteful expenditure, involving at the lowest estimate a total of five millions sterling!

The alternative is to decentralise the teaching by placing several university centres—say four to begin

with—on the outskirts of London in places where each could be furnished with at least one hundred acres of land at a total cost of no more than is asked for the 11½ acres now proffered.

The advantages of such outlying centres would be: (1) The students could live in the neighbourhood of the institution, either at home or in hostels, and would not be compelled to take a long journey twice a day. (2) There would be abundance of room for all purposes, including recreation. (3) Each subject would be able to have its own area of ground for the erection of a suitable institute, and for permitting future extension. (4) Temporary buildings might be put up until experience has shown what character of permanent buildings ought to be erected. (5) The classes would not be of an unwieldy size; for we might assume for each of the four centres two hundred and fifty students, instead of the one thousand assumed for the central institute, *i.e.* for each practical subject.

American experience has shown that one hundred acres is not too much land to provide for the buildings of a modern university, and a scheme which assumes that a single university for a city the size of London can be accommodated in a space of ten, or even twenty, acres is self-condemned at the outset.

E. SHARPEY SCHAFER.
University New Buildings, Edinburgh, June 7.

High Rates of Ascent of Pilot-Balloons.

ABNORMAL rates of ascent shown by pilot-balloons have in recent years aroused considerable interest amongst aerologists. These digressions were mostly ascribed to the occurrence of vertical air-currents, but three years ago Wenger (*Annalen der Hydrographie*, 1917, Hamburg) suggested[1] that, for the greater part, the observations did not permit of such an explanation. He advanced the theory that these abnormal rates were chiefly caused by increased turbulence of the air, and he stated, making use of the Lindenberg material, that the rates observed depended on different conditions of the air, as wind, friction, etc., which, no doubt, must have a notable influence on its turbulence.

In the same journal, however, it was shown that a large number of observations made at Sofia (Bulgaria) gave strong evidence that actually large vertical air-currents had occurred, and that the high and low rate should, without doubt, be ascribed to upward and downward movements of the air.

Between 1912 and 1917 much material regarding these rates was gathered by the Batavia Observatory, and peculiar circumstances make this material of critical value, for it consists of three series taken in three localities differing in character, the ascents being made at various hours during the day and night.

The first series was taken at Batavia during the dry, sunny season, when land- and sea-breezes are developed strongly; and the second at Bandung, a town situated on a plateau 700 m. above sea-level, surrounded by mountains. Insolation in the latter case did not differ much from that at Batavia; the mountain- and valley-breezes were only slight.

The third series was taken by Dr. Boerema on a small coral islet in the Java Sea at the end of the west monsoon. There the influence of insolation and of land- and sea-breezes is practically nothing.

Most of the balloons were observed from two points; also, up to 1 or 1½ km., half-minute readings were taken between the usual observations made every minute. Balloons of different weight and pattern were used; those for the night carried a second balloon filled with acetylene and a burner. For each kind I calculated the average rate observed at the level of 3 or 4 km., and derived from it the rate for the layers beneath by applying the formula

$$v = ad^{-\frac{1}{2}}$$ (d = air density).

For the light balloons there remained, of course, a change of rate with height, which, however, I was unable to calculate, but I surmise was small.

The accompanying diagram (Fig. 1) gives for the lowest layers up to 3 km. the departures of the mean rates observed from those at 3 or 4 km. Evidently it displays the contrast between the land and the sea influence, *i.e.* on land the rates are increased by day, but are normal by night, while at sea there is no distinct increase in the average rate.

At Batavia the positive digression runs parallel with the strength of the sea-breeze and with the change of

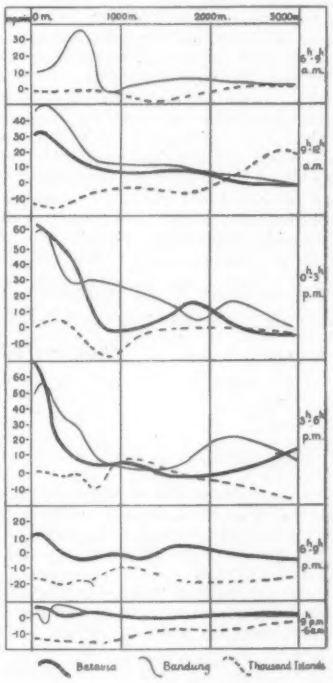


FIG. 1.

wind velocity caused by the Espy-Köppen effect. At Bandung also this parallelism seems to exist.

Consequently, at first sight, the explanation proposed by Wenger might be given: During the day turbulence is enhanced on land by increase of wind velocity, by friction with the surface, and by insolation; at sea, on the contrary, these causes are not present. However, on more detailed examination this explanation is not confirmed. Thus the rate of ascent did not prove to depend on wind velocity, as the following figures clearly show:

Batavia.

9 a.m.–noon		Noon–3 p.m.		3–6 p.m.	
Δ Rate of ascent m. p. min.	Wind velocity m. p. sec.	Δ Rate of ascent m. p. min.	Wind velocity m. p. sec.	Δ Rate of ascent m. p. min.	Wind velocity m. p. sec.
3	3·8	−4	8·7	4	8·0
63	4·0	−64	7·5	56	5·6
—	—	136	6·4	133	6·9

[1] It came under my notice only a few months ago.

Bandung.

9 a.m.–6 p.m. Δ Rate of ascent m. p. min.	Wind velocity m. p. sec.
10	2·9
39	3·7
103	2·3

Also, the wind velocity scarcely ever reached the values (>15 m. per sec.) at which, according to Wenger, the influence of wind velocity begins to increase turbulence, so that a notable increase in the rate of ascent is to be expected.

Moreover, insolation is strongest between 9 a.m. and noon; afterwards, clouds mostly weaken it or prevent further increase. On the other hand, the rate of ascent at Batavia between noon and 3 p.m. considerably exceeds that between 9 a.m. and noon.

Thus an explanation of the observed rates by Wenger's theory practically fails; on the contrary, the supposition of vertical air movement is tenable.

For some years I supposed that the air had to rise in columns, and, the surrounding air being sucked in, the balloon in most cases would also be sucked in, and afterwards would not leave the ascending air-columns. Later I read that J. S. Dines was inclined to this conception. The criticism of this view offered by Wenger must be accepted; but why should not both causes co-operate in the lowest strata?

Indeed, I have found that my results and those of Wenger coincide regarding the change of rate of ascent when, passing upwards, wind velocity varies.

Denoting this change by $10^2 \frac{dv}{dz}$ (v=wind velocity in m. per sec., and z=height in m.), I found:

Batavia.			*Thousand Islands.*		
$10^2\frac{dv}{dz}$	Δ Rate of ascent m. p. sec.	No. of cases	$10^2\frac{dv}{dz}$	Δ Rate of ascent m. p. sec.	No. of cases
1·2	0·7	22	0·7	1·3	28
−1·1	−1·0	42	−0·4	−1·1	38
−2·2	−0·6	20			

As these values show, the change of rate with wind velocity is not developed strongly, the percentage of cases in which dv/dz and Δ rate were of the same sign being respectively for Batavia and the Thousand Islands 63 and 68 only.

Finally, we are obliged to accept the view that in the sea-breeze the air must rise as the breeze dies out at a moderate distance from the coast. Also, the air seems to rise no higher than the sea-breeze itself, the rate of rise diminishing with its horizontal velocity.

Moreover, I think the material collected on and near Java is not favourable to the idea of such a preponderating influence of turbulence as Wenger accepts; on the contrary, it corroborates the assumption of ascending columns.

The formation of the fine-weather cumuli, to be observed every sunny day in the tropics, is clear evidence of the general occurrence of these ascending air columns. W. VAN BEMMELEN.

On board s.s. *Tjisondari*, Pacific.

A New Method for Approximate Evaluation of Definite Integrals between Finite Limits.

GAUSS, I believe, gave a very large number of forms for approximate evaluation of definite integrals between finite limits. His formulæ are all based, like Tchebycheff's rules, on the assumption that the integrand is expressible approximately by a finite number of terms of the series $a+bx+cx^2+dx^3+\ldots$. His plan was to use a minimum number of suitably weighted ordinates to give him the exact value of the integral for a specified number of terms.

Taking the range of integration to be from -1 to $+1$, which can be done without any loss of generality, his simplest integral is

$$\int_{-1}^{+1} f(x)dx = f(-x_1)+f(x_1),$$

where

$$x_1 = \tfrac{1}{\sqrt{3}}.$$

This formula with two ordinates gives *exact* values for

$$\int_{-1}^{+1}(a+bx+cx^2+dx^3)dx,$$

and is in that respect on a par with Simpson's formula, which has three ordinates weighted in the proportions 1, 4, 1, and situated at the ends and middle of the range.

The next Gauss formula is

$$\int_{-1}^{+1} f(x)dx = \tfrac{1}{9}\{5f(-x_1)+8f(0)+5f(x_1)\},$$

where

$$x_1 = \sqrt{\tfrac{3}{5}}.$$

This is exact up to and including the term in x^5 in the series. Put in the same form as Mr. Merchant's formula (which is also exact up to the x^3 term) in NATURE of June 3, it becomes

$$\int_0^1 f(x)dx = \tfrac{1}{18}\{5f(x_1)+8f(x_2)+5f(x_3)\},$$

where

$$x_1 = 0{\cdot}1127, \quad x_2 = 0{\cdot}5, \quad x_3 = 0{\cdot}8873.$$

The third formula is

$$\int_{-1}^{+1} f(x)dx = \frac{1}{(A+B)}\Big[Af(-x_1)+Bf(-x_2)+Bf(x_2)+Af(x_1)\Big]$$

where

$$A = \tfrac{1}{2}-\tfrac{1}{6}\sqrt{\tfrac{5}{3}}, \quad B = \tfrac{1}{2}+\tfrac{1}{6}\sqrt{\tfrac{5}{3}},$$
$$x_1^2 = \tfrac{3}{7}+\tfrac{2}{7}\sqrt{\tfrac{6}{5}}, \quad x_2^2 = \tfrac{3}{7}-\tfrac{2}{7}\sqrt{\tfrac{6}{5}}.$$

Transferred to the other form, this becomes

$$\int_0^1 f(x)dx = 0{\cdot}1739f(x_1)+0{\cdot}3261f(x_2)+0{\cdot}3261f(x_3)+0{\cdot}1739f(x_4)$$

where

$$x_1 = 0{\cdot}0694, \; x_2 = 0{\cdot}3300, \; x_3 = 0{\cdot}6700, \; x_4 = 0{\cdot}9306.$$

This formula is exact up to and including the term in x^7.

It may be noticed that although the weight factors are now incommensurate, they can be written with a very close degree of approximation as $\frac{4}{23}$ and $\frac{1}{46}$, and the integral then takes the form

$$\int_0^1 f(x)dx = \tfrac{1}{46}[8f(x_1)+15f(x_2)+15f(x_3)+8f(x_4)].$$

Possibly Mr. Merchant might find that this form would be useful in ship design. The positions of the ordinates is not sufficiently close to even tenths to permit of such further modifications being made, but if the ship's half-length were divided into fifteen sections, the ordinates would come very near the first, fifth, tenth, and fourteenth. Some of the higher Gauss integrals might be found to fit in even more conveniently. THOS. Y. BAKER.

Admiralty Compass Observatory, Slough, Bucks, June 10.

The Royal Military Academy.

SIR GEORGE GREENHILL in an article in NATURE of April 29, entitled "Artillery Science," passes severe strictures on the Royal Military Academy—"The Shop." These reflect on the whole staff, especially the military staff, and as the officers are not permitted

to defend themselves in public journals, I ask permission as a civilian to say a few words in defence.

War is the best test of a military establishment. During the war the R.M.A. worked continuously, and turned out more than two thousand young officers who were able to proceed, either direct or after a short additional course, straight to the battlefields and take their full share of the work with their batteries or field companies. Courses in field telephony were also given to an equal number of officers, n.c.o.'s, and men of the new armies at a critical period when there were few instructors elsewhere. There were many other activities. Owing to the seclusion in which the Academy works, there were few except those immediately connected with it who had any idea of the great amount of work actually done.

Science was encouraged by all three of the Commandants during this period, and dealt with all military applications up to date. The teaching of wireless was commenced in the R.M.A. eighteen years ago, and that it was not used at a much earlier period of the war was certainly no fault of the R.M.A. During the war an opportunity was given for the study in detail of the course given to French artillery officers. In science there was nothing to be learnt from it, and the same was reported in other subjects. There is no reason to believe that the German schools were any better.

The R.M.A. has been submitted to inquiry from outside three times in the past twenty years: First, by Lord Esher's Committee shortly after the Boer War; next, in 1911, an inspection by specialists from the Board of Education; and thirdly, an inspection by the Board of Education in February last. The first two reports were entirely favourable, and no doubt can still be obtained. The latest, which is not yet permitted to be published, gives a fair picture of the place and its work. It also contains criticisms and recommendations which, if adopted by the War Office, would improve the establishment, and consequently the Army. I understood from the inspectors that they had come to the same conclusion as those on a former occasion, viz. "The Academy is very efficient."

The academy is not perfect, but its improvement, not its abolition, is what is desirable. Merely to move it to a new situation while retaining the old system would do no good; and to amalgamate it with Sandhurst would, in my opinion, in these specialising days, be a mistake.

Improvements must commence at Whitehall, for it is at the War Office that all decisions as to courses of study, staffs, etc., are made. Scientific advisers from the learned societies would help, for it is scarcely to be expected that the officers there can be in touch with scientific progress. There are still some who do not yet believe in the importance of science, and are under the impression that any R.E. officer can teach all that is necessary.

The half-dozen civilians mentioned in the article are responsible for mathematics and science. They must now be almost alone amongst those engaged in education in the public service in having no security of tenure and no retiring allowance. Their numbers, now reduced below pre-war level, might be increased with advantage, but I understand that it has been decided to dispense with civilians in science altogether in a year or so, and no doubt the mathematical staff will follow. Their places will be filled by officers. I think that most of those who have an intimate knowledge of these subjects will agree that this is a retrograde step.

Mathematics and science should have adequate civilian staffs of properly trained men. Appointments should be permanent and emoluments correspond to those of the military staff, with retiring allowances on the Civil Service scale. Members of the civilian staff could then, without anxiety, devote themselves to the work, which necessarily takes a different direction from that at a civil institution, and even the best civilians require a considerable time before becoming familiar with military requirements and military apparatus.

Accommodation for research by the staff should be provided. Officer instructors, in science at least, should be students as much as instructors, so that at the end of their appointments they would rejoin the Army reasonably up-to-date in their subjects. Cadets with a special bent should be given opportunities so far as possible to do extra work, to assist them in deciding on their future course and to prepare them for it. The present two years' course is too short to do much in any direction, as it has to be divided between many subjects. An increase of length would be an advantage.

The R.M.A. is a cadet school, and aims at producing the useful regimental officer, but it cannot produce experts. For the artillery there should be a further selection of young officers, who should receive additional training at the Ordnance College, which should be a genuine artillery university, and not merely a training place for officers desirous of semi-civil appointments. It should be the function of this establishment to turn out the artillery expert, and if it were not done the blame would lie there. The R.E. would probably require a similar establishment or an extension of the "School of Military Engineering." Co-operation between the various military schools is advisable, but, above all, there should be some system established for the regular distribution of information on military matters amongst the departments concerned. At present it is exceedingly difficult for those engaged in one department or school to find out what is happening elsewhere.

The equalisation of pay will now enable cadets to make a free choice between the R.A. and the R.E., but those scientifically inclined will still probably choose the latter.

I do not believe much is to be gained by imitating foreign institutions. In the four years and a half of the war we succeeded in overtaking the German in every direction, in spite of his long preparation. Our aim now should be to avoid retrogression: for that is our chief danger.

J. YOUNG.
Science Department, Royal Military Academy,
Woolwich, S.E.18, June 3.

The Separation of the Isotopes of Chlorine.

ON certain plausible assumptions concerning the nature of chemical equilibria and the properties of isotopes, it should be possible to separate the isotopic varieties of an element like chlorine by means of a reversible chemical change in the gaseous state, provided that the number of atoms of chlorine in the reacting compound is unequal to the number of atoms in the resulting compound.

Thus, for the sake of argument, assume that chlorine contains two isotopes the atoms of which can be represented by Cl and Cl′, then there would be three classes of molecules, namely, Cl_2, Cl_2', and ClCl′, of which the corresponding liquids and solids would have the very nearly same vapour pressure at the same temperature. Accordingly, if it may be assumed that 2 mols. of ClCl′ can be converted into 1 mol. of Cl_2, and 1 mol. of Cl_2' in the liquid forms at the same temperature without the expenditure of work,

$$[Cl_2][Cl_2']=[ClCl']^2, \quad . \quad . \quad . \quad . \quad (i.)$$

where the square bracket has the usual significance of concentration.

Now in Deacon's process, which is represented by the chemical equation

$$4HCl + O_2 = 2H_2O + 2Cl_2,$$

we should have

$$\frac{[Cl_2]}{[Cl_2']} = \frac{[HCl]^2}{[HCl']^2} \quad . \quad . \quad . \quad . \quad . \quad (ii.)$$

Taking $\frac{[HCl]}{[HCl']}$ as 3, $\frac{[Cl_2]}{[Cl_2']}$ is 9, provided that the temperature and concentration of the oxygen are selected so that the concentration of the chlorine is small at equilibrium.

But the ratio of the atoms of the two varieties of chlorine is given by

$$\frac{[Cl_2] + \frac{1}{2}[ClCl']}{[Cl_2'] + \frac{1}{2}[ClCl']},$$

and this, by equations (i.) and (ii.), is equal to $\frac{10 \cdot 5}{2 \cdot 5}$, which differs appreciably from 3.

Deacon's process is selected merely for the purpose of illustration.

If the isotopic varieties of chlorine are inseparable by the method above indicated, it is clear that

$$\frac{[Cl_2] + \frac{1}{2}[ClCl']}{[Cl_2'] + \frac{1}{2}[ClCl']} = \frac{[HCl]}{[HCl']} = \frac{[Cl_2]^{\frac{1}{2}}}{[Cl_2']^{\frac{1}{2}}} \quad . \quad (iii.)$$

whence

$$2[Cl_2]^{\frac{1}{2}}[Cl_2']^{\frac{1}{2}} = [ClCl'] \quad . \quad . \quad . \quad . \quad (iv.)$$

Now consider two solids composed entirely of Cl_2 and Cl_2' molecules respectively. The vapour pressures of the two solids will be very nearly (if not exactly) the same—say p—at the same temperature t.

Evaporate a gram-molecule of both the solids. Reduce the pressure of the Cl_2 isotope to p_1, and that of the Cl_2' isotope to p_2, and then introduce both unsaturated vapours into a van't Hoff's equilibrium box. The total work done in these operation is

$$R\tau \log_e \frac{p^2}{p_1 p_2}.$$

Now remove 2 gram-molecules of the ClCl' variety (which from equation (iv.) will obviously be at the pressure $2\sqrt{p_1 p_2}$) from the equilibrium box. Increase the pressure to p, and finally condense at this pressure to the solid form. The work done during this series of operations will be

$$R\tau \log_e \frac{4p_1 p_2}{p^2}.$$

Therefore the total work performed in effecting the change represented by the equation

$$Cl_2 \text{ (solid)} + Cl_2' \text{ (solid)} = 2ClCl \text{ (solid)}$$

is $R\tau \log 4 = A$.

But it is difficult to understand how the free energy A could differ appreciably from zero if the molecular heats of the three varieties of chlorine are nearly the same—as they are generally supposed to be—and if the entropy of the reactants Cl_2 and Cl_2' is equal to that of the resultant $2ClCl'$ at the absolute zero temperature, as Nernst postulates in his heat theorem.

An attempt is being made in the Jesus College Laboratory to separate the isotopes of chlorine by a method similar to that given above. A negative result would be difficult to reconcile with Nernst's theorem that $\frac{dA}{dt} = 0$ at the absolute zero.

D. L. CHAPMAN.

Jesus College, Oxford.

A Note on Telephotography.

HAVING examined a number of formulæ for the circle of illumination in telephotography, and found them all to be inapplicable in certain cases, I propose the following, which seem reasonable and are applicable in all cases. These formulæ are particularly vital in the line along which telephotography is at present developing.

Let C_r = Full circle of illumination.
C_x = Circle of equal ,,
C_w = Mean circle of ,,
M = Magnification.
f_1 = Focus of positive lens.
f_2 = ,, negative ,,
b = Diameter of positive lens.
c = ,, negative ,,

Then

$$C_r = \frac{M^2(f_1 c + f_2 b) - M f_2 b}{M(f_1 - f_2) + f_2} \quad . \quad . \quad . \quad (1)$$

$$C_x = \frac{M^2(f_1 c - f_2 b) + M f_2 b}{M(f_1 - f_2) + f_2} \quad . \quad . \quad . \quad (2)$$

$$C_w = \frac{M^2 f_1 c}{M(f_1 - f_2) + f_2} \quad . \quad . \quad . \quad . \quad . \quad (3)$$

The last formula (3) is not only the simplest, but it is also the accurate value for the circle when the aperture (b) of the positive lens is small. It is the mean between the full (1) circle and the evenly illuminated (2) circle. The first (1) is the most usually used. It gives the diagonal of the largest plate that can be employed. The second (2) gives the circle that is equally illuminated. If it is possible to make the aperture (b) of the positive lens equal to the diameter (c) of the negative lens, this formula becomes the simplest.

$$C_x = Mc.$$

I have received an opinion on the above from a distinguished authority upon geometric optics. He is of the opinion that it is necessary to add that certain assumptions have been made in deciding these formulæ. These assumptions are (α) that the lenses are thin, (β) that the aberrations may be neglected, and (γ) that the focal lengths of both lenses, f_1 and f_2, are definite quantities.

(α) Photographic positive lenses are usually not thin. Negative telephoto lenses, except some high-power lenses, are always thin. With a thick lens the "equivalent planes" for the two sides (the "object space" and the "image space") are different. As all measurements in the above formulæ are made from the back of the positive lens and the front of the negative lens, no confusion can arise between the equivalent planes.

(β) The aberrations of a photographic lens are negligible.

(γ) The positions of the equivalent planes of the negative lens move over a small space with a change of magnification. This quantity is negligible in deciding the circle of illumination, which does not need to be known exactly.

The position of the equivalent plane of the whole varies greatly with a change of distance of object. This can be completely corrected by substituting the "back conjugate focus" of the positive lens for the distance, in place of the "principal" focus (f_1) in the above formulæ. In telephotography the object is usually "at infinity," and this correction is not necessary.

In a short note it is not possible to do more than indicate the conditions in which these formulæ may be used. Consult Lan-Davis on "Telephotography" and Beck and Andrews's "A Simple Treatise on Photographic Lenses" (Appendix) for "equivalent planes."

A. B.

Recent Researches on Nebulæ.[1]

By MAJOR WILLIAM J. S. LOCKYER.

THE latest volume (No. xiii.) in the series of Publications of the Lick Observatory, situated on Mount Hamilton, California, is completely devoted to a series of well-laid-out investigations of the study of the forms, distribution, velocities, and spectra of the nebulæ. The volume is one of extreme interest and importance, and will become a classic for a considerable time on those interesting objects scattered throughout the heavens.

In these days, when the study of the evolution of the stars is occupying a position in the front rank, the more detailed information of the nebulæ, their composition, structure, and movements, is of fundamental importance, for these bodies are criteria in the evolutionary stages of stars.

Considerations of space will not permit here more than an outline of the contents of this substantial volume, which includes six separate contributions, each devoted to a special research, and a large number of beautifully reproduced plates.

Part i. is contributed by Mr. H. D. Curtis (pp. 11–42), and deals with the descriptions of 762 nebulæ and clusters photographed with the Crossley reflector. It comprises all photographs of these objects which have been taken with this instrument since the year 1898, when systematic work was commenced, forming, therefore, a valuable homogeneous research.

It is interesting to note the types of the 762 entries, which Mr. Curtis divides as follows: 513 spiral, 56 diffuse, 36 globular, 24 sparse, 78 planetary, 8 dark, and 47 unclassified. Mr. Curtis is led to believe that all the many thousands of nebulæ not definitely to be classed as diffuse or planetary are true spirals, and that "the very minute spiral nebulæ appear as textureless discs or ovals solely because of their size."

In estimating the probable total number of the spiral nebulæ, Mr. Curtis concludes that at least 700,000, and very probably 1,000,000, small spirals are within the reach of large reflecting telescopes. A chart showing the distribution of regions on which small nebulæ were counted indicates also the position of the galactic plane, and the paper concludes with reproductions of a few typical nebulæ.

The second part, by the same author, is devoted to a study of occulting matter in the spiral nebulæ (pp. 45–54), and its object is to show that the occurrence of such dark bands running down the length of spiral nebulæ seen edgewise is a relatively common feature. While a description of these appearances is not necessarily satisfactory to those who have not had occasion to observe them or to see the original photographs, Mr. Curtis includes seventy-seven reproductions. By the kindness of Prof. W. W. Campbell, reproductions of some of these spirals are here given (Figs. 1, 2, and 3).

References are made to other evidences of occulting matter in the sky, such as the cutting off in the number of stars round a nebula, "coal sacks" or starless regions, dark nebulæ, etc. (see Fig. 4). The fact that many spectroscopic binaries indicate a constant radial velocity for the H and K lines, different from the periodic shift of the other lines in the spectrum, suggests, according to the author, the interposition between us and the binary of a cloud of non-luminous matter, though, as he says, there are some difficulties in this hypothesis. The subject of the peculiar grouping of the spiral nebulæ about the galactic poles is also mentioned.

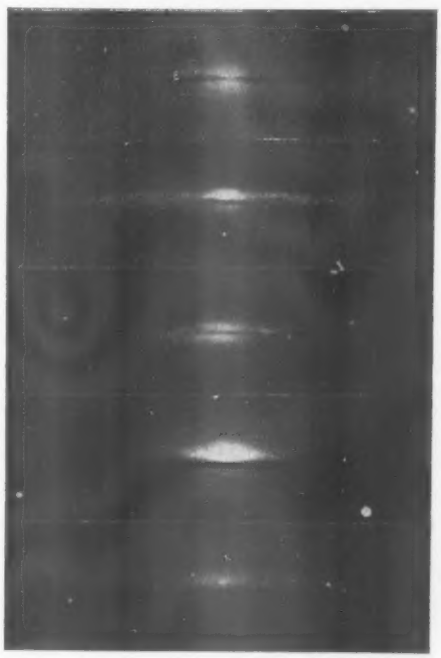


FIG. 1.—Spiral nebulæ seen almost exactly edgewise and showing indubitable evidence of dark lanes. (H. D. Curtis.)

Part iii. is entitled "The Planetary Nebulæ," and in it Mr. Curtis brings together the results of a research on a series of photographs of all the planetary nebulæ north of 34° S. declination. Seventy-eight of these objects are dealt with, and they are all reproduced either by photographs or by drawings (with scale). Drawings were resorted to only when the objects were so small that they could not be reproduced by the process of photo-engraving, or when great differences in brightness between the central and the faint outlying portions were encountered, which

[1] University of California Publications. Publications of the Lick Observatory. Vol. xiii. Pp. 268+50 plates. (Berkeley: University of California Press, 1918.)

prevented an adequate representation of all the details of the nebula (Fig. 5). This collection of illustrations, showing the forms assumed by the planetary nebulæ, will throw considerable light upon the structure and life-history of these bodies. An important addition to the illustrations is that the exposure for recording a selected portion of the Orion nebula has been used as a standard, and the time necessary for recording the brightest portion of a planetary nebula is given in relation to that standard. Thus

FIG. 2.—Spiral nebulæ seen almost, but not exactly, edgewise, and some the planes of which make a small but appreciable angle with the line of sight, showing clear evidence of dark lanes. (H. D. Curtis.)

an approximation to the relative brightness of the planetary nebulæ is secured.

With regard to the distribution of these nebulæ in space, an interesting diagram of which is given, Mr. Curtis finds that the smallest objects are almost invariably in, or very close to, the Milky Way, while the larger planetaries, "the giants of the class," somewhat more frequent in the vicinity of the galactic plane, are, "on the whole, fairly uniformly distributed over the entire sky." It is concluded, therefore, that these giants may be in the Galaxy, but the nearest to us, and, therefore, would only appear outside, and he suggests their inclusion in parallax programmes, as many of them have central stars sufficiently bright for that purpose.

Further reference cannot be made here to this interesting paper except to add that the author classifies the planetary nebulæ according to their appearances, and then discusses these forms in relation to homogeneous oblate spheroidal or

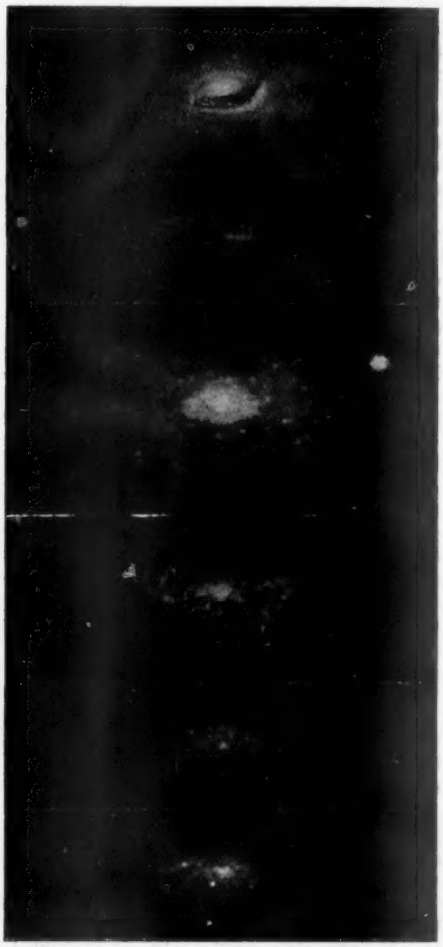


FIG. 3.—Spiral nebulæ making a much greater angle with the line of sight, showing clear-cut dark lanes (2903, 4212), and a lane absolutely black and cutting across a whorl at the right end (4826). (H. D. Curtis.)

homogeneous truncated spheroidal shells under various conditions.

Prof. W. W. Campbell and Mr. J. H. Moore are the authors of part iv., which is devoted to the spectrographic velocities of the bright-line nebulæ (pp. 77–183). The observations are a combination of those made with the 36-in.

refractor at Mount Hamilton and with the 37-in. Mills reflector at Santiago, Chile, and they were commenced in the year 1913. The list includes 138 nebulæ with bright lines in their spectra. In the earlier part details are given with respect to the spectroscopes employed, the probable errors of the results, and a description of the observations made at the two stations.

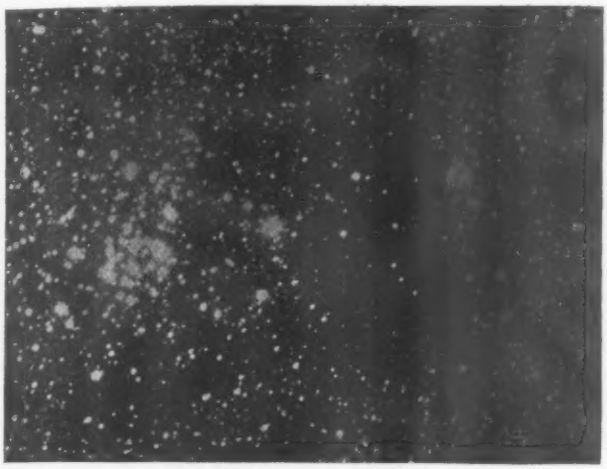


FIG. 4.—A "dark nebula" (17h. 57m., −27°50′) visible through its projection upon the background of stars, and not considered to be "a hole" in the Milky Way. Note the circular protuberance at the south-west corner, as clear-cut as an ink-drop and perfectly dark. (H. D. Curtis.)

The detailed results of each object are then given in the order of right ascension. Attention may be directed to the fact that the lengths of the slits of the spectroscopes employed were in most cases more than sufficient to cover the width of the images of the objects photographed, so that the spectra of the central and outlying portions of the nebulæ should both be recorded.

In a further table the final deduced radial velocities of each object observed are given. The observations recorded are evidence of most extensive and arduous work, and the numerous observations of each object considerably emphasise this fact. The accompanying illustration (Fig. 6) shows a photograph of the chief nebular line in N.G.C. 2392, and exhibits the kind of structure displayed from which the internal motion of the nebula was deduced.

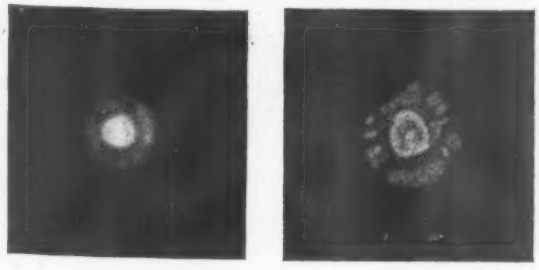


FIG. 5.—On the left a photograph of N.G.C. 2392, a double-ring planetary nebula; and on the right a composite drawing of the same made from several photographs to show details of the structure not attainable from any single photograph. (H. D. Curtis.)

The average magnitudes of the derived values for the velocities are as follows: Calling the nebulæ less than 5 secs. in diameter "stellar," and those greater than 5 secs. "non-stellar," the mean velocity for thirty-one "stellar" nebulæ is 28 km. per sec., and for sixty-five non-stellar nebulæ 31 km. per sec. with reference to the stellar system. For evidence of rotation or internal motion in the planetary nebulæ, the lines in the spectra of forty-six such objects have been examined in detail and are here discussed. Of these, twenty-five gave evidence of internal effects, while nineteen, and possibly two more, indicated rotations about axes roughly perpendicular to the line of sight. It is worthy of note that the most elongated planetary nebulæ showed the highest rotational speeds.

The study of the radial velocities of numerous parts of the Orion nebula shows a range in velocities from +9·7 km. to +24·9 km., and, as the authors state, the results do not favour the hypothesis of a rotation as a whole, but the observed differences appear to be local or regional in character.

Mr. R. E. Wilson contributes part v. of this volume (pp. 187–90), which deals with the radial velocity of the greater Magellanic cloud. In 1914 it was pointed out that several gaseous nebulæ in this region exhibited very large and approximately equal radial velocities, so Mr. Wilson presents the results of his study of the cloud as a whole. The author upholds this view after his survey, for he finds that, observing seventeen planetary nebulæ in this region, the radial velocities lie between +251 km. and +309 km., an average of +276 km. Correcting this mean for solar motion, the mean velocity is +261 km. per sec. This average, compared with the mean velocity deduced in part iv. for other planetary nebulæ, points to

FIG. 6.—A photograph of the chief nebular line in N.G.C. 2392. The slit of the spectroscope was placed along the major axis of the nebula. (W. W. Campbell and J. H. Moore.)

exceptional conditions in this region. Mr. Wilson refers to the spiral appearance of this great cloud and to the high velocities observed in spiral nebulæ, nebulæ which may be considered as isolated island universes similar to our Milky Way system, suggesting that the great cloud may afford an opportunity for the study of detailed characteristics of spiral nebulæ.

Part vi., the last of the series of the important contents of this volume, is contributed by Mr. W. H. Wright, and deals with the subject of the wave-lengths of the nebular lines and general observations of the spectra of the gaseous nebulæ (pp. 193–268). The matter falls under three headings: (1) The measurement of wave-lengths and the intensities of the nebular lines; (2) the study of the nebular nuclei; and (3) the investigation of the distribution of nebular radiations throughout the nebulæ; and is accompanied by a series of plates, which demonstrate, more than text can do, the fine definition and great scale of the photographs of the spectra of the nebulæ which served as his data. Fig. 7 is an illustration of the spectrum of N.G.C. 6818, taken with the slitless spectrograph with an exposure of four hours. It does not seem that the statement could be contradicted that the wave-lengths and intensities of the nebular lines deduced will be used as a standard in this branch of physical astronomy for some time.

FIG. 7.—The spectrum of N.G.C. 6818, which records images of a variety of shapes and sizes, most of them having the appearance of a horse-shoe, the open end of the shoe lying to the north. Some of the images show mottlings or condensations scattered along the shoe or ring. (W. H. Wright.)

This research is very opportune, because more detailed facts were required to help in the unravelling of the relationships between nebulæ as such, nuclei of nebulæ, and bright-line stars such as Wolf-Rayet stars. As the whole problem of the nature of stellar evolution is that of the solution of the relationship between nebulæ and stars, the study of the question is of vital importance. The idea of a falling temperature continuing throughout the whole life-history of a star has more recently given place to the hypothesis, apparently a very natural one, of a star in its early career increasing in temperature, reaching a maximum of development and temperature, and afterwards cooling until the invisible stage is reached. In the light of these hypotheses Mr. Wright, as the result of his research, expresses his view as follows:—

> There are at present two general conceptions as to the nature of stellar evolution, one of which assumes a falling temperature throughout the period of a star's development, while the other predicates a rise to maximum and a subsequent decline; both of these views assume the nebula as the primordial state. As between these two hypotheses, the present observations undoubtedly favour the first, since they add to the proof that the gaseous nebulæ are associated only with the hot stars.

While the above is one of the main conclusions derived by Mr. Wright from this research, there are many other points of particular interest to which limitations of space forbid reference in this article.

It is interesting to compare a direct photograph of a nebula with its spectrum taken with a slitless spectrograph. Nebulæ when photographed with the latter instrument present remarkable varieties of form and size corresponding to different nebular lines in the spectrum, while the direct photograph shows only a form resulting from the integration or the fitting together of the component images of the different forms and sizes. The prismatic images afford a means, therefore, of detecting the differences in distribution of the component gases of the nebula, and indicate that the view of a nebula in a telescope or on a direct photograph is not the best means of studying the complex structure of these bodies.

In conclusion, it may be stated that this addition to the University of California Publications is a valuable contribution, and sustains the high standard of the researches which emanate from the Lick Observatory under the able directorship of Prof. W. W. Campbell.

The Importance of Meteorology in Gunnery.

By DR. E. M. WEDDERBURN.

AT the commencement of the war the knowledge of the effect of wind and of the density of the air on the flight of a shell was elementary. It was assumed by the gunners that the wind was of the same direction and strength at all heights reached by the projectile, and that the density of the air decreased with altitude according to an artificial convention. The corrections for wind and density which the gunner was taught to apply were supposed to be referable to the meteorological conditions observed by him at the battery, but he was not taught how

these conditions should be observed, nor that the observation of surface air temperature was an exceedingly difficult matter.

When an Army Meteorological Service was established in 1915 it was a small unit which had to justify its existence, and in the course of exploring fields of usefulness it found the artillery ready and anxious for improved meteorological information. The shell from a high-velocity gun may rise to a height of 20,000 ft. or more, and surface conditions may be a very misleading guide. But to ask the gunner to use detailed observations of wind and of atmospheric pressure and temperature at different heights up to 20,000 ft. under active service conditions, and without previous training, was useless. The meteorologist, having found a sphere of usefulness, had to put his information in a form in which it could be used with the existing artillery organisation. It is already suggested in some quarters that the meteorological service adequately met the artillery's requirements during the war without any peace-time organisation, and that therefore it is unnecessary now to keep any close *liaison* between the gunner and the meteorologist. In the writer's view this is a great mistake. The meteorological service was able to help the gunner by doing work which the gunner could have done if he had received the proper training, and it is necessary that he should do this work for himself in order to make the best use for his particular gun of data supplied to him by the meteorologist.

The artillery organisation for meteorological corrections consisted in the supply to gunners of tables of variations in line and range produced by winds constant in velocity and direction at all heights and of variations in range produced by changes in surface temperature and pressure, based on the assumption that the ratio between the actual air density and that assumed in the construction of the range table was the same at all heights. It was a fairly obvious first step to suggest that the gunner should be supplied with a fictitious wind such that, when used with the usual table of variations, the proper correction was applied for the cumulative effect on the projectile before reaching the target of a wind varying with height. Such a wind came to be called the equivalent constant wind, or the ballistic wind, and methods of estimating it were investigated simultaneously by the Meteorological Section, R.E., and the Anti-Aircraft Experimental Section (A.A.E.S.) of the Munitions Inventions Department (M.I.D.). At first the investigations were entirely independent and from different points of view, but later they were continued in close co-operation under the sympathetic guidance of the Ordnance Committee.

An initial difficulty of great importance was that the ballistic wind is not the same for any two trajectories, even for the same wind distribution. But, fortunately, the height to which a projectile rises when fired on the flat is nearly the same for all projectiles which have the same time of flight, and also the length of time which such projectiles spend in any particular stratum of the atmosphere is nearly the same. Thus, though the range of a high-velocity gun may be double that of a howitzer for the same time of flight, yet the projectiles in each case rise to nearly the same height, and are affected by the same winds for nearly the same length of time. To a first approximation, therefore, the ballistic wind is the same for every projectile having the same time of flight, and if a selection of such winds for different times of flight is given to the gunner, he can choose the one most nearly suited to the conditions under which a shoot is taking place.

As a first approximation, in the calculation of the ballistic wind it was assumed that the atmosphere was stratified into several layers, and that in each layer the wind was constant in velocity and direction, though varying from layer to layer. It was further assumed that the effect of the wind in any layer on a projectile was proportional to the time spent by the projectile in that layer and to the density of the air. "Weighting factors" for the portion of the total displacement of the projectile caused by unit wind in any layer were thus determined. Subsequent mathematical analysis showed that the "weighting factors" varied materially for each different trajectory, and also differed for winds across and along the line of fire. Considerable refinements were introduced for the analysis of experimental shoots on which the construction of range tables was based. The researches of the A.A.E.S., M.I.D., though principally directed towards anti-aircraft gunnery, included careful and detailed discussions of variations in the trajectory of a shell produced by varying wind and density, and made the careful analysis of such experimental shoots possible. For a considerable period, however, the facilities afforded by the field meteorological service in the different theatres of war made possible much greater accuracy of correction than had been aimed at in the experimental shoots from which range tables were compiled. Ultimately average weighting factors, deduced from theoretical factors computed in a large number of cases, were adopted for different times of flight, and the method of constructing the ballistic wind for use in the field became standardised.

The second step was the introduction of the idea of ballistic density—a fictitious density such that when used with the usual tables of variations the proper correction is applied for the effect of an abnormal vertical distribution of density. Fortunately, the pressure and temperature which practically determine the air's density may be considered separately. If it is assumed that the vertical temperature distribution is known and remains unchanged while changes in pressure are registered at the surface of the earth, it is easily shown that there are proportional changes in pressure, and therefore in density, at all heights. Thus the surface barometer reading affords a real,

though partial, index of the density of the air at any height. From this the third step followed—the idea of a ballistic temperature such that when used in conjunction with surface pressure the ballistic density was arrived at. Methods of computing density weighting factors were developed by the A.A.E.S., M.I.D., and by using these factors temperature weighting factors were computed (which allowed for the variations in the vertical pressure distribution consequent on any variation in the temperature distribution). Here, again, the factors vary for each trajectory, but the differences between trajectories are considerably less than in the case of winds, and there was little difficulty in arriving at the best average factors to employ for field use.

By the employment of wind and temperature weighting factors, very numerous meteorological observations were made available for the use of gunners in the most convenient form. Ballistic winds and temperatures for several selected times of flight were telegraphed to the batteries at frequent intervals, and the information given in the meteorological telegrams, in conjunction with the barometric pressure measured at the battery, gave the gunner data which required no reduction, but could be used directly for applying corrections from the range table. It is, of course, essential that the results of meteorological observations should be provided "red hot" to the gunners, and methods of computation were so perfected, and so high a degree of skill was attained, that the calculation of ballistic winds from pilot-balloon observations kept pace with the observation of the balloon itself, and no time was lost in putting the information in the form in which it was readily usable by the gunner.

A single concrete example may suffice to illustrate the importance of the methods which were introduced by the meteorologists.

If a projectile were fired due south, with a time of flight of 50 sec. (*i.e.* rising to a height of about 10,000 ft.), under the following weather conditions, viz. :—

Height in ft.	Wind Velocity f.s.	Wind Direction °	Temperature °F.	Barometer
Surface	8	110	50	
2,000	40	175	40	
4,000	45	185	30	
6,000	50	190	19	30·00 in. (Normal)
8,000	45	190	8	
10,000	60	185	−2	

Then, if surface conditions are used for arriving at the appropriate corrections to apply, we have for a certain gun that the wind will reduce the range of the gun by 13 yards and deflect the projectile towards the west 60 yards. The surface temperature being 10° F. below the range table normal of 60° F., the range will be further reduced by 42 yards—a total loss in range of 55 yards.

But the ballistic wind for the above conditions is a wind of 44 f.s. from direction 185°, and the ballistic temperature is 36° F. For the same gun and projectile this wind would produce a deflection towards the east of 35 yards, a decrease in range due to wind of 660 yards and to abnormal temperature (and density) of 407 yards—in all more than 1000 yards. Thus the corrections applied by pre-war methods would have entailed in this case an error in range of about 1000 yards, and in line of about 100 yards.

Instead of anti-aircraft gunnery being considered as a special department of gunnery, it is more logical to consider fire on the flat as a specially simple case of the more general science of gunnery. In a very real way the development of the science was due to the researches of the A.A.E.S., M.I.D., and to the methods employed by that department in the analysis of fuse trials and in the calibration of guns. For anti-aircraft fire under active service conditions the application of meteorological corrections did not reach the same degree of organisation as for fire on the flat, for the application of corrections is a much simpler problem in the latter case. But in experimental work full account was taken of all the meteorological information available. Thus one of the main sources of errors in shooting was eliminated, and the investigation of many ballistic problems made possible.

Obituary.

S. RAMANUJAN, F.R.S.

SRINIVASA RAMANUJAN, whose death was announced in NATURE of June 3, was born in 1888, in the neighbourhood of Madras, the son of poor parents, and a Brahmin by caste. I know very little of his early history or education, but he became a student in Madras University, and passed certain examinations, though he did not complete the course for a degree. Later he was employed by the Madras Port Trust as a clerk at a salary equivalent to about 25*l.* a year. By this time, however, reports of his unusual abilities had begun to spread, and, I believe owing to the intervention of Dr. G. T. Walker, he obtained a small scholarship which relieved him from the necessity of office work and set him free for research.

I first heard of Ramanujan in 1913. The first letter which he sent me was certainly the most remarkable that I have ever received. There was a short personal introduction written, as he told me later, by a friend. The body of the letter consisted of the enunciations of a hundred or more mathematical theorems. Some of the formulæ were familiar, and others seemed scarcely possible to believe. A few (concerning the distribution of primes) could be said to be definitely false. There were no proofs, and the explanations were often inadequate. In many cases, too, some curious specialisation of a constant or a parameter made

the real meaning of a formula difficult to grasp. It was natural enough that Ramanujan should feel a little hesitation in giving away his secrets to a mathematician of an alien race. Whatever reservations had to be made, one thing was obvious, that the writer was a mathematician of the highest quality, a man of altogether exceptional originality and power.

It seemed plain, too, that Ramanujan ought to come to England. There was no difficulty in securing the necessary funds, his own University and Trinity College, Cambridge, meeting an unusual situation with admirable generosity and imagination. The difficulties of caste and religion were more serious; but, owing to the enterprise of Prof. E. H. Neville, who happened fortunately to be lecturing in Madras in the winter of 1913–14, these difficulties were ultimately overcome, and Ramanujan arrived in England in April, 1914.

The experiment has ended in disaster, for after three years in England Ramanujan contracted the illness from which he never recovered. But for these three years it was a triumphant success. In a really comfortable position for the first time in his life, with complete leisure assured to him, and in contact with mathematicians of the modern school, Ramanujan developed rapidly. He published some twenty papers, which, even in war-time, attracted wide attention. In the spring of 1918 he became the first Indian fellow of the Royal Society, and in the autumn the first Indian fellow of Trinity. Madras University endowed him with a research studentship in addition, and early in 1919, still unwell, but apparently considerably better, he returned to India. It was difficult to get news from him, but I heard at intervals. He appeared to be working actively again, and I was quite unprepared for the news of his death.

Ramanujan's activities lay primarily in fields known only to a small minority even among pure mathematicians—the applications of elliptic functions to the theory of numbers, the theory of continued fractions, and perhaps above all the theory of partitions. His insight into formulæ was quite amazing, and altogether beyond anything I have met with in any European mathematician. It is perhaps useless to speculate as to his history had he been introduced to modern ideas and methods at sixteen instead of at twenty-six. It is not extravagant to suppose that he might have become the greatest mathematician of his time. What he did actually is wonderful enough. Twenty years hence, when the researches which his work has suggested have been completed, it will probably seem a good deal more wonderful than it does to-day. G. H. HARDY.

PRINCIPAL SIR JOHN HERKLESS, D.D., LL.D.

SIR JOHN HERKLESS, whose death we regret to announce, was the son of an engineer in Glasgow; he was born on August 9, 1855, and educated in the High School before entering the University of his native city. His career as a student was varied, and his fellow-students did not think it outstanding. He not only studied arts, but also attended medical classes. Like some men who have afterwards made their mark in life, he disliked mathematics, but was fond of philosophy, and finally he decided to study for the Ministry, and was duly licensed, though he obtained no degree from his *Alma Mater*. For a short time he lectured on English literature at Queen Margaret College, then became an assistant-minister until 1883, when he was appointed to the parish of Tannadice in Forfarshire.

The death of the eloquent Principal Cunningham made a vacancy in St. Mary's College, St. Andrews, and it was rumoured that Dr. Herkless would be appointed to the post (divinity). Prof. Mitchell, however, resigned his chair of Church history, and he was appointed, whilst Prof. Stewart, of Aberdeen, was made principal. About this time the strained relations with Dundee in regard to the medical school, and the claims of St. Leonard's Parish in connection with the College Chapel, gave the forceful new professor of Church history an ample field for polemics. He took the side of Dundee, and opposed the parish. Besides stray papers, he afterwards published two books, viz. "Francis and Dominic" and "Richard Cameron," whilst, along with Mr. (now Prof.) R. K. Hannay, he edited a volume of documents pertaining to St. Leonard's College, and four volumes on the archbishops of St. Andrews. He was chairman of the St. Andrews School for Girls Company. He was appointed principal of the University by Mr. Asquith on the death of the distinguished educationist, Sir James Donaldson.

Though not a man of original cast of intellect, Sir John Herkless had great versatility and shrewdness, and was not devoid of ambition (as he himself stated), his main field for advancement being politics. He was diligent in his duties as principal, but he had little time to make noteworthy advances. His lamented death on June 11 occurred after an operation, and whilst he was in the midst of plans for the improvement of the University.

THE death of MR. CHARLES E. RHODES is announced in *Engineering* for June 11, and will be regretted by a large circle who knew him through his activity in colliery developments. Mr. Rhodes was born in 1849, and died on June 7 last. Since December, 1873, he held the position of engineering manager for Messrs. John Brown and Co., Ltd., for whom he sank several shafts and developed a number of pits. He became a member of the Institution of Civil Engineers in 1890, and at various times was president of different institutions connected with mining. He was appointed a member of the Standing Committee on Mining in 1916, and joined the Coal Conservation Committee in the same year.

WE regret to note that the death of MR. WILLIAM SHELDON is recorded in *Engineering* for June 11 as having occurred on May 20. Mr. Sheldon was in his sixty-ninth year, and had been connected with the steam plough works belonging to Messrs. Fowler since 1879. He was president of the Leeds Association of Engineers in 1898-99

Notes.

THE Linnean Society will be engaged to-day, June 17, in celebrating the centenary of Sir Joseph Banks, Bart., who died on June 19, 1820. On the death of Carl von Linné in 1778, Banks endeavoured to buy his herbarium, but that was acquired by Linné's son for the remainder of his short life. Five years later, when the herbarium was again for disposal upon the death of the younger Linné, Banks had changed his mind, for when the collections were offered he passed the offer to Dr. J. E. Smith, recommending the purchase, as it would be of great value to him as a young naturalist. On getting the herbarium Smith spent the winter of 1784–85 in collating his new acquisition with the Banksian collection, with the invaluable help of Jonas Dryander, Banks's factotum; then, after a tour abroad, Smith took counsel with his friends, and the Linnean Society came into being. Banks was chosen as honorary member immediately, and retained that position until his death. Besides continual gifts of books, the cast from Inlander's relief of Linné, which was the model for Wedgewood's plaque, and objects of natural history, he paid for the entire cost of illustration for the first volume of the Transactions. It is well that such liberal actions should be recalled to the memory of the present generation.

WE have received from the secretary of the Rubber Growers' Association particulars of a competition which has been organised by the association with the view of extending the industrial uses of rubber. A sum of 5000*l.* is offered for ideas and suggestions in this connection, the amount to be divided into the following awards, viz. one prize of 1000*l.*, three prizes of 500*l.* each, ten prizes of 100*l.* each, and a sum not exceeding 1500*l.* to be divided amongst the remaining competitors whose suggestions are considered to be practical, according to the relative value of the proposals. Among the conditions of the competition it is noted that special value will be attached to ideas of a thoroughly practical nature, supported by detailed information likely to make them effective; and that the relative value of the suggestions which are deemed practical will depend upon the quantity of raw rubber which their adoption would absorb, special consideration being given to proposals likely to utilise rubber in large quantities. The most important condition, however, is that relating to the protection by letters patent of any process, method, or apparatus submitted by competitors; this regulation is too long to quote in detail here. Full particulars of the competition may be obtained from the Rubber Growers' Association (Department C), 38 Eastcheap, E.C.3; the closing date of the competition is December 31 next.

THE Albert medal of the Royal Society of Arts for 1920 has been awarded to Prof. A. A. Michelson, For.Mem.R.S., professor of physics in the University of Chicago, and Nobel laureate for physics in 1907.

THE enterprise of the Royal Horticultural Society in holding a three-days' show at Cardiff on July 6–8 marks a new departure in the society's history. Not in the present generation has it held such a meeting in the provinces, and it has now taken this step to foster the interest in gardening and the production of home-grown produce that it did so much to develop during the war period. The scientific section will contain exhibits showing how to identify and overcome the various garden pests, as well as displays of the various appliances used in repelling their attacks.

THE David Syme prize, with medal, for the year 1920 has been awarded to Mr. Frederick Chapman, palæontologist to the National Museum and lecturer in palæontology in the University of Melbourne. Mr. Chapman, before his first appointment in Australia, was known to a wide circle in London through his work under Prof. Judd and his association with Prof. T. Rupert Jones in the investigation of fossil Foraminifera. Foraminifera have always remained his special object of research, but he has published a large number of papers in all branches of palæontology, including a revision of the fossil fish-remains of New Zealand. Few men have rendered the results of their observations available with such zeal and regularity, and Mr. Chapman, from the date of his earliest papers, when he described the preparation of thin sections of minute objects for the microscope, has brought to his painstaking studies the enjoyment of an artist in his work.

AT the anniversary meeting of the Linnean Society on May 27, the following officers and members of council were elected:—*President:* Dr. A. Smith Woodward. *Treasurer:* Mr. H. W. Monckton. *Secretaries:* Dr. B. Daydon Jackson, Prof. E. S. Goodrich, and Dr. A. B. Rendle. *Council:* Mr. E. G. Baker, Mr. H. Bury, Prof. Margaret Benson, Mr. E. T. Browne, Mr. Stanley Edwards, Prof. J. B. Farmer, Prof. E. S. Goodrich, Capt. A. W. Hill, Dr. B. Daydon Jackson, Mr. C. C. Lacaita, Mr. G. W. E. Loder, Mr. H. W. Monckton, Mr. R. I. Pocock, Dr. A. B. Rendle, the Rt. Hon. Lionel Walter, Baron Rothschild, Dr. E. J. Salisbury, Mr. C. E. Salmon, Miss A. Lorrain Smith, Lt.-Col. J. H. Tull Walsh, and Dr. A. Smith Woodward. The president has appointed Mr. E. T. Browne, Prof. J. B. Farmer, Mr. H. W. Monckton, and Mr. R. I. Pocock vice-presidents. Dame Helen Gwynne-Vaughan was presented at the anniversary meeting with the Trail award and medal, and Sir Ray Lankester with the Linnean medal.

A SUCCESSFUL meeting of the British Lampblown Scientific Glassware Manufacturers' Association, Ltd., was held on June 8 at the Abercorn Rooms, Great Eastern Hotel. Mr. Douglas Baird, vice-president of the association, who occupied the chair, in proposing the toast of "The B.L.S.G.M.A.," gave a short history of the formation of the association. The manufacturers who were members of the association were engaged in work which could be truly designated a "master-key industry," because there was no trade or profession that could be successfully carried on without the aid of one or other of the instruments manufactured by its members. The association was formed during the war because it was found by the Government that there was a great demand for all kinds of instruments for the fighting forces which previous to hostilities had been introduced into this country from abroad,

and more particularly from Germany. The Government experienced great difficulty in getting in touch with manufacturers, and it was at the suggestion of the Ministry of Munitions that the B.L.S.G.M.A. was formed. Mr. Baird emphasised the necessity of each member in the association uniting to their utmost in promoting and fostering the industry. He pointed out that it was only by united effort to turn out instruments of the highest class of manufacture that the country could hope to keep out the importation of foreign glassware.

SIR C. H. READ, in his presidential address delivered before the Society of Antiquaries, does not take an optimistic view of the prospects of archæological research. While the late German Government lavished treasures on the Berlin museums, the British Museum, our one institution archæological in its aims, is hampered by lack of funds. Again, the regulations against the export of specimens from countries under our control have proved to be ineffective. For example, specimens found in Cyprus are smuggled to any other art centre rather than to London, and the silver treasures from that island passed easily into the Pierpont Morgan galleries in New York. The same result of Government action is anticipated in India. The president is, however, scarcely fair in his strictures on the Indian Government. Why, he asks, are the Indian museums filled with statuary of the Buddhist age?—things which he believes are hated by Mussulmans and almost equally disliked by Hindus. He forgets that many of the Indian Mussulmans, being converts from Hinduism, have in a measure lost that hatred for representations of the human form which survives in orthodox cities like Cairo. Hindus have recognised Buddha as an incarnation of Vishnu, and the ignorant Hindu villager often worships a figure of the Master as a representation of some local deity, male or even female. But Sir Hercules Read is well justified in pleading for the development of excavation in Babylonia and in Egypt, in which latter country Prof. Flinders Petrie has done admirable work with very limited resources. He also wisely lays stress on the fact that, while our galleries abound in examples of art in its highest forms, we have comparatively little to illustrate the everyday social life of the populations which are now subject to our control.

THE tenth International Cotton Congress was held in Zurich on June 9–11. In the course of its proceedings a highly suggestive paper was read by Dr. W. Lawrence Balls, scientific expert and adviser to the Fine Cotton Spinners' Association, Ltd., Manchester, on "The Nature, Scope, and Difficulties of Research," in which he dealt with the foundation of research, the past and present scope of the research on cotton, the British organisation of cotton researches, and international research. The demand for scientific research, with the view of enlarging the possibilities of the industry, embracing not only the cultivation of the plant, but also every subsequent process in its utilisation, has been induced by various changes in recent years. There is a vast accumulation of experience in the cotton industry, together with a small stock-in-trade of general knowledge. Most of the work of the first decade undertaken by the scientific workers will have to be spent in defining what the spinner knows, and then in reducing the incoherent mass of details to a small number of generalisations easy to grasp. The question of the method of utilisation of the results of research which may be condensed under the title of publication is summed up in a line: To ascertain the true facts, to conceal nothing known, and to take personal responsibility. There must be individualism in effort and communism in knowledge, which is put forward as the code of the pure scientific worker. With respect to a code of research for industry, the author insists on the need for individual effort, but also that after five years the industrial research worker and his employer-colleague shall make known the true facts ascertained, which, whilst giving full advantage to the business concerned, shall yet give fair and full assistance to the general advance of man's power over his environment.

IN *Man* for May Mrs. M. E. Cunnington describes a curious stone mould found on the Worms' Head, Glamorganshire. It is made of two pieces of fine-grained red sandstone about an inch thick. On the corresponding sides of the two stones are matrices for casting four objects: a large ring ornamented with a raised pattern of S-like scrolls enclosed by two narrow rows of irregular chevrons or waved lines, a ring with seven star-like rays, a second ring, and another smaller with a raised pattern of waved lines or loops with seven points. It is suggested that this ornamentation has been designed with some reference to sun-worship, the disc, the rayed star, and the S scrolls being all well-known solar symbols derived from the wheel. From the objects found in association with these moulds it may be inferred that they belong to the Early Iron age. This part of the coast, though difficult of access by land, was easily reached by sea from other parts of Britain and from the Continent. The moulds may thus possibly have been introduced from abroad.

THE Oxford University Press has issued a revised edition of its General Catalogue, which was first produced in 1916. It is not only an excellent description of the varied activities of this great publishing institution, but it is also valuable as a fine example of scientific bibliography, and forms very interesting reading. The Press offers this valuable service to science and literature that the profits derived from school books and other more or less popular works are devoted to the publication of expensive volumes of permanent value which the ordinary publisher may hesitate to produce. One book, Woide's Coptic New Testament, published in 1799, is still on sale. There is an account of the "Dictionary of National Biography," the copyright of which was presented to the University by the family of its founder, the late George M. Smith. Preliminary work under the direction of Mr. H. W. Carless Davis is now in progress with the view of maintaining and extending its usefulness. A history, of course, is given of what is now called the "Oxford Dictionary," which since the

death of Sir John Murray in 1915 has been controlled by Dr. H. Bradley and Messrs. W. A. Craigie and C. T. Onions. Nine of the ten volumes are complete, and as steady progress in the tenth volume is being made we may soon look forward to the completion of this monumental work.

IN the Annual Report of the Director of the Field Museum of Natural History, Chicago, for 1919, perhaps the most novel pages are those dealing with the work of the botanical laboratories established by Mrs. Stanley Field. Their main object is to make reproductions of living plants for exhibition in the museum. To accomplish this the plants are studied in the field, wherever they are best to be seen. Thus the first four and a half months of the year were spent in Florida, at a station of the U.S. Department of Agriculture, to secure studies and material for such plants as the coconut palm, the banana, the pineapple, and the Florida cycad. The most perishable parts were cast and coloured, and plaster moulds were made of other parts, formalin material packed and sent to the museum, and photographs, colour sketches, and detail studies secured for use after return. Reproductions were made of many other plants cultivated in the garden of the station. A set of tomatoes attacked by various fungi, then under investigation at the station, was reproduced, and pure cultures of the fungi were obtained with the view of making an enlarged model of each fungus for exhibition alongside the infected fruit.

FEW works of the same size have had so wide an influence on geological thought as R. Liesegang's "Geologische Diffusionen," published in 1913. Applications of the author's views on zonal deposition are to be found, with excellent illustrations, in Professional Papers 107 (p. 156) and 104 (p. 45) of the U.S. Geological Survey. In the former case banded jasper-rock is considered; in the latter, the very common occurrence of bands of iron hydroxide. Messrs. Bastin and Laney, in Paper 104, have made useful experiments with interfusing solutions of ferrous sulphate and sodium hydroxide.

A COLOURED geological map of Western Australia, called a sketch-map, but none the less valuable to libraries, accompanies the Annual Progress Report of the Geological Survey of that State for 1918 (published 1919). Its scale, 1 in. to 50 miles, or about 1 : 3,000,000, is large enough to enable us to appreciate the immense extent of Nullagine (Late Pre-Cambrian?) beds in the north-west, with their auriferous conglomerates; the Jurassic fringe on the west coast; and the Cretaceous overflow on Palæozoic strata in the south-east. An interesting case of serviceable limestone formed by capillary action in sand-dunes is described on p. 14 of the report.

A SUMMARY of the weather for the spring season, comprised by the thirteen weeks ending May 29, is given in the *Weekly Weather Report* issued by the Meteorological Office. Mean air temperature for the period was above the average in all districts of the British Isles, the largest excess being 3·2° F. in England E. and 2·9° F. in England S.E. In Ireland the excess was not more than ½° F., and in Scotland it was only about 1°. At the close of the season the sheltered thermometer exceeded 80° F. in most of the English districts. The day-degrees above 42° F. were largely in excess of the normal over the whole kingdom, especially in England E. and in the English Channel, whilst the day-degrees below 42° F. were largely deficient everywhere, especially in the Midland Counties and in England E. and N.E. Rainfall was everywhere in excess of the normal, the greatest excess being 5·67 in. in England N.W. In the English Channel the excess was only 0·59 in., and in England S.E. and E. 0·63 in. and 0·67 in. respectively. The duration of bright sunshine was normal in Scotland N., but deficient in all other parts of the British Isles. In Scotland W. the deficiency was 109 hours, and in England N.W. and Ireland S. 91 hours.

THE second part of the current volume of the Proceedings of the Royal Irish Academy consists of a paper by the late Prof. J. A. McClelland and Mr. A. Gilmour on the electric charge on rain. The observations were made in a small quadrangle at the back of University College, Dublin, between January 1 and August 31 last year. The results for non-thunderstorm rain are that 73 per cent. of it was charged positively, and 84 per cent. of the electricity brought down was positive. The average charges brought down by the rain were 0·21 electrostatic unit positive and 0·08 negative per c.c. of water. The average vertical currents were $1{\cdot}6\times10^{-18}$ amperes per sq. cm. positive and $0{\cdot}5\times10^{-18}$ negative. Drops below $0{\cdot}08\times10^{-3}$ c.c. were always negatively charged, but there appeared to be no relation between the size of the drop and the magnitude of its charge. Thunderstorm rain was more highly charged than ordinary rain and about equally positive and negative. Snow was more often negative than positive, small hail always negative, and large hail always positive, the charges per c.c. exceeding those on ordinary rain and often those on thunderstorm rain.

IN Publication No. 298 of the Carnegie Institution of Washington (1919) Messrs. E. L. Nichols and H. L. Howes, with the collaboration of Messrs. E. Merritt and D. T. Wilber and Miss F. G. Wick, give the results of a very exhaustive investigation of the fluorescence and absorption spectra of uranyl salts. The authors have examined a large number of simple and double salts, the influence of water of crystallisation and of crystalline form, and the polarised fluorescence of crystals at ordinary temperatures and at the temperature of liquid air. The results obtained at low temperatures are of particular interest, for under these conditions both the absorption and fluorescence bands, which at ordinary temperatures are so diffuse that it is difficult even to locate the positions of the maxima with great precision, are resolved into a number of comparatively sharp components the homologous members of which can be arranged in series having constant wave-number

differences. The authors arrive at the generalisation that resolution of the bands on cooling depends on the existence of regular crystalline structure; as an example of this, the broad bands observed in uranium glass are not further resolved on cooling to the temperature of liquid air. It is shown that many of the apparent shifts of the bands with change of temperature are to be referred to the relative enhancement or diminution of the components of the bands. A discussion of different types of phosphoroscope is included as an appendix.

THE May lecture of the Institute of Metals on "Recent Progress in Thermo-Electricity" was delivered by Prof. C. A. F. Benedicks, of Stockholm University, on June 10, Engineer Vice-Admiral Sir George Goodwin, president, in the chair. Prof. Benedicks first gave a short summary of his theoretical views upon the metallic conduction of electricity. A consequence of this theory was that one has to conclude that even in a single homogeneous metal thermo-electric currents do occur, and not only when two different metals are present. Prof. Benedicks gave a concise demonstration of the most important experimental evidence of the truth of this conclusion, utilising for this purpose various metals. In liquid mercury it had been possible for him definitely to prove the existence of thermo-electric currents, thus disproving the negative results of previous workers. A consequence of what the lecturer termed his "homogeneous *thermo-electric* effect" was that there must exist the *reverse* effect, the "homogeneous *electro-thermic* effect," including as a special case the well-known Thomson effect. The reality of this effect was duly made clear. A specially interesting demonstration was of a new rotating thermo-electric apparatus made entirely of copper and rotating in a magnetic field, the driving force originating solely from unequal heating (by means of a tiny gas jet) of thin strips of copper. The point at which the new knowledge brought forward by Prof. Benedicks might have some practical interest lay in the possibility of reducing the thermal conductivity of metals by insulated subdivision into fine wires without impairing the electrical conductivity. The demonstrations were carried out with the aid of a galvanometer kindly provided by the Cambridge and Paul Instrument Co.

DRS. A. HARDEN AND S. S. ZILVA, continuing their work on accessory food substances, publish in the *Biochemical Journal* for April a paper entitled "The Antiscorbutic Requirements of the Monkey." The authors point out that as the clinical symptoms of scurvy induced in the monkey are similar to those occurring in human subjects suffering from a similar disease, the monkey has been more and more extensively employed as an experimental animal. On the other hand, comparative scarcity, high price, and greater duration of experiment render the monkey in many instances less suitable than the guinea-pig for the study of experimental scurvy. In order to translate results obtained with one animal into the terms of the other Drs. Harden and Zilva have attempted to establish a quantitative relationship, as regards dose and time, between them. In the work described five monkeys fed on a scorbutic diet of rice, wheat germ, salt mixture, and butter received respectively 0·5 c.c., 0·75 c.c., 1 c.c., 2 c.c., and 5 c.c. respectively of orange juice daily. The animals receiving only 0·5 c.c. or 0·75 c.c. developed scurvy with fatal results, whilst the one receiving 1 c.c. only suffered from a mild attack, and in the cases of 2 c.c. and 5 c.c. doses the animals remained quite healthy. The authors conclude that the minimum daily dose of fresh orange juice for a monkey (weighing 2–3 kilos.) is 1–2 c.c., which is approximately the amount required by a guinea-pig weighing 300–400 grams. Whilst, however, the minimum dose of antiscorbutic required by the two animals is of the same order, the disease develops in the guinea-pig in three weeks, but only after two months in the monkey.

IN pursuance of his campaign for recognition as a pioneer inventor of oil engine cycles, we have received a number of documents from Mr. Herbert Akroyd Stuart, formerly an assistant at Finsbury Technical College and now of Claremont, in Western Australia. One type of Mr. Stuart's engines has been manufactured on a large scale by Messrs. Hornsby, of Grantham. The cycle in this engine is carried out in a cylinder fitted with a hot bulb, the walls of which are kept hot during ordinary working by the heat developed during explosion. Air is drawn into the cylinder through a side-port in front of the bulb, and oil fuel injected into the bulb during the suction stroke. Compression follows, and at the end of this stroke ignition takes place due to the temperature developed by the hot walls and by the compression. Mr. Stuart's other cycle has not been worked commercially to any extent. It also is carried out in a hot-bulb cylinder, and consists in drawing in air only during the suction stroke, compression of this air, and injection of oil fuel into the bulb during the early part of the working stroke, the temperature being then sufficient to cause the oil to burn readily. Both these cycles were invented in 1890. Mr. Stuart objects, and rightly so, to the name "semi-Diesel" being applied to engines working on these cycles. He has first claim as the inventor of hot-bulb engines, and the term "Akroyd cycle" would be suitable. The Diesel engine proper has no hot bulb; air alone is compressed to a very high pressure (500 lb. per sq. in.), and the temperature due to compression alone is sufficient to ignite the oil fuel which is injected during the early part of the working stroke. The term "Diesel engine" might continue to be used for such engines. The high pressures used in the Diesel engine and the extensive use of the engine for marine purposes gave rise to a demand for an engine working with lower pressures, and the past few years have seen a great development in hot-bulb engines. Someone acquainted with Diesel engines and probably unaware of Mr. Stuart's prior work named these "semi-Diesel," a term which may very well be dropped in favour of Akroyd engines, if only for the sake of historical accuracy.

Our Astronomical Column.

THE MASSES OF THE STARS.—The mass of a star is perhaps its most important element, but it is one that can be ascertained only in exceptional cases. Prof. H. N. Russell, in a paper read at the twenty-first meeting of the American Astronomical Society, gathered together all the evidence, direct and indirect, on the subject, grouping the results by spectral type.

Method I. is the usual one for visual binaries the orbits and parallaxes of which are known; Method II. is similar, where the parallax and relative motion, but not the orbit, are known; Method III. is from spectroscopic binaries where both spectra are shown, a mean inclination being assumed; and Method IV., the vaguest of all, derives the parallaxes of binaries from their proper motions.

The resulting mean masses for the pairs of stars are:—

Spectrum		I.	II.	III.	IV.
B_0–B_5	... ...	—	10·4	17·5	7·1
B_8–A_5	... ...	5·9	3·0	4·0	8·4
F–G	giant	—	—	3·9	8·1
K–M	giant	—	—	—	9·8
F–F_5	dwarf	3·5	3·4	—	2·5
F_8–K_0	dwarf	1·8	1·4	—	0·7
K_5–M	dwarf	0·7	1·0	—	—

The sun's mass is taken as 1.

The following formulæ are given for the hypothetical parallax (h) of systems of mean distance a, and period P: $h=f\frac{a^3}{P^2}$: or where s is the apparent distance and w the apparent relative motion, in seconds of arc per annum, $h=0{\cdot}409fs^3w^2$.

The constant f has the value 0·50 for all giant stars, 0·58 for dwarfs of spectrum A, 0·72 spectrum F, 0·86 spectrum G, 1·00 spectrum K, and 1·14 spectrum M. The probable error is given as 12 per cent. where the first formula can be used, and as 22 per cent. in other cases.

THE PLANET JUPITER.—The Rev. T. E. R. Phillips, director of the Jupiter section of the British Astronomical Association, contributes an interesting article on the planet to the June number of *Scientia*. After giving a *résumé* of Jovian phenomena during the last twenty years, including the red spot and the south tropical disturbance, Mr. Phillips notes the startling change in the aspect of the planet which took place early in 1919; the disturbance and the red-spot hollow both practically disappeared, though the spot itself survived. Discussing the physical condition of Jupiter, he notes the similarity to the sun in density, in varying rotation periods according to latitude, and in the dark belts which are comparable with the spot zones. He suggests that the red spot may indicate a vast cyclonic movement in the atmosphere, noting that this view would explain the rapid passage of the dark matter of the tropical disturbance round the spot when the two are in conjunction. He notes, in conclusion, the importance of Jovian study from the point of view of cosmogony, since it illustrates a stage intermediate between the solar condition and the earliest geological periods.

PARALLAX WORK AT THE SPROUL OBSERVATORY.—The list of stars with known parallaxes is being rapidly extended, thanks to the extensive organised campaign carried on by many observatories which possess large equatorials. Dr. Miller, of the Sproul Observatory, has published a useful list of fifty observed parallaxes (Proc. Amer. Phil. Soc., vol. lix., No. 2). Five stars on the list have parallaxes above 0·1″, viz. W.B. (1) V. 592=0·146″, 9 Argus=0·121″, *i* Persei=0·120″, Lalande 17161=0·104″, and W.B. (1) IV. 1189+0·103″. The values found for γ^1 and γ^2 Andromedæ are 0·021″ and 0·005″; those for the preceding and following components of the wide pair 16 Cygni are +0·037″ and +0·018″. In each of these systems the true parallaxes of the components are presumably the same. The discordances are a measure of the probable errors, which in each case are of the order of 0·01″.

An interesting feature is the closeness with which the new figures verify many of Prof. H. N. Russell's hypothetical parallaxes, deduced from assumptions regarding the masses of binaries.

Nuclear Constitution of Atoms.[1]

BY SIR ERNEST RUTHERFORD, F.R.S.

THE idea of the nuclear constitution of atoms was developed from an examination of the scattering of swift α-particles in passing through matter, and the advance afterwards made was due to the proof by Moseley of the close connection between the atomic number of an element and the nuclear charge. The accurate determination of the nuclear charge is of prime importance. Recent unpublished experiments by Mr. Chadwick in the Cavendish Laboratory indicate that the nuclear charge on an atom in fundamental units is equal to the atomic number within an accuracy of about 1 per cent. It follows that there is a region surrounding the nucleus where the law of the inverse square holds accurately. The problem of the constitution of the atom divides itself naturally into two parts: one the arrangement of the external electrons on which the ordinary chemical and physical properties of the atom depend, and the other the constitution of the nucleus on which depend the mass of the element, the possibility of isotopes, and radio-activity. The nucleus is composed of positively charged units and negative electrons in very close combination, and estimates of its dimensions are possible from a study of the collision of α-particles with light atoms. Close to the nucleus there is a rapid change in the magnitude and direction of the forces, probably in part connected with the deformation of the nucleus structure under the intense forces which arise in a close collision.

Unless the nuclei are very stable, it is to be anticipated that they would be deformed, and possibly broken up, as a result of a direct collision with swift α-particles. In previous experiments evidence was given that long-range particles resembling hydrogen atoms were liberated by the passage of α-particles through pure nitrogen. New experiments have been made to determine by a modified method the nature of these particles by bending them in a magnetic field. The amount of deflection of the particles liberated from the nitrogen of the air was shown to be the same as for H atoms arising from a mixture of hydrogen and carbon dioxide. This showed definitely that hydrogen is one of the products of the disintegration of the nitrogen atom, and is one of the original components of the nitrogen nucleus. The possibility that the long-range particles are atoms of mass 2, 3, or 4 carrying a single charge may be definitely excluded.

The deflection in a magnetic field of the short-range particles which are liberated from nitrogen and oxygen, and were originally assumed to be recoil atoms of these elements, is not only much greater than that to be expected for such recoil atoms, but is also greater than the α-particle but less than the H atoms liberated from a mixture of hydrogen and carbon dioxide.

[1] Synopsis of the Bakerian Lecture delivered before the Royal Society on June 3.

There is evidence that these particles are atoms of mass about 3, carrying two charges. Consequently the atom of nitrogen can be disintegrated in two ways by collision with α-particles: one by the escape of an H atom, and the other by the expulsion of mass 3, and both processes occur independently. Atoms of mass 3 are also released from oxygen atoms, but H atoms cannot be detected.

It may be concluded, therefore, that atoms of mass 3, carrying two positive charges, are components of the nuclei of nitrogen and oxygen.

This new atom is to be regarded as an isotope of helium, and should give nearly the same spectrum. The energy of motion of the atom of mass 3 expelled from nitrogen and oxygen is about 8 per cent. greater than the original energy of the α-particle, showing that energy is liberated as a result of the disintegration. The atoms of mass 3 probably consist of three hydrogen nuclei with one binding electron, and atoms of helium of four hydrogen nuclei and two electrons. Apart from hydrogen itself, these atoms are important secondary units in the building up of atomic nuclei. In the light of the new experimental evidence, examples are given of the possible modes of formation of isotopes and possible structures of nitrogen and oxygen nuclei are considered. It is pointed out that close combinations may exist of H nuclei and electrons, giving rise to atoms of zero nuclear charge, and that such a conception is needed to explain the evolution of the heavy elements.

The Rockefeller Gift to Medical Science.

AS was announced in the *Daily Mail* of June 11, the Rockefeller Foundation for Medical Research has made the generous gift of a sum of 1,205,000*l.* for the advancement of teaching and research in the Medical School of University College and Hospital. Owing to the inconsiderate and premature manner in which the statement was made public, it is natural that some mistakes should have been made and the objects of the gift in certain respects misunderstood.

The reason for the delay in making a public announcement is that the Senate of the University of London has as yet had no opportunity of formally accepting the gift. When this had been done it was the intention to make it public through appropriate channels and in such a way that the people of England might appreciate the intention of the donors to give a manifest proof of the friendliness of their feelings towards the work that we are doing here and their appreciation of its value. We have reason to believe that they particularly wish this aspect to be emphasised. It should be remembered that the object of the Rockefeller Foundation is "the welfare of mankind," so that its benefits were not intended to be confined to the United States. The members of the Foundation desire it to be regarded as entrusted to them for this purpose, and the present endowment is not meant in any way as a charitable gift. In view of statements to the contrary, it is necessary to make it plain that no conditions are attached, and that the recipients are left free in a very wide sense to make the best use of the money for the benefit of medical science, and especially as to the details of its application. It will naturally be understood that the manner of its use has been the subject of much discussion between representatives of the Rockefeller Foundation and the institutions receiving the gift.

With regard to the objects to which it is proposed to devote the endowment, a few words on the history of the negotiations may be of interest. Towards the end of last year two representatives of the Rockefeller Foundation, Dr. Wickliffe Rose (General Director of the International Health Board) and Dr. Pearce (Adviser in Medical Education to the Foundation), arrived in London. Before proceeding further they called at University College. In the absence of Prof. Starling, they were received by the present writer, whom they gave to understand that they had come to make inquiries into the conditions of medical education in London. They were accordingly informed of the recent creation of medical and surgical "units," of their situations and the names of various gentlemen associated with these units from whom they might obtain further information. This they proceeded to do. Early in the present year they made another visit to University College with definite proposals, and were seen by Prof. Starling and Prof. Elliot Smith, who showed them what was necessary to be done for the adequate provision of instruction and research in the fundamental sciences of anatomy, physiology, and pharmacology. It was clear to them that the most pressing need was the building of a new anatomical institute, although the medical sciences themselves naturally required the larger proportion of any proposed gift.

In April four representatives of University College and Medical School visited the United States for the purpose of further conference. These were the Provost (Sir Gregory Foster), Dr. Blacker (Dean of the Medical School), Prof. T. R. Elliott (professor of medicine), and Prof. Elliot Smith (professor of anatomy). On their return they brought back the definite offer of this extremely generous gift, and speak with the greatest appreciation of the friendliness of the manner in which they were received, the spirit in which the offer was made, and in which it was impressed upon them that it should be accepted.

Owing to the premature publication of the scheme it was necessary to call a general college meeting on Friday last, at which the Provost made a statement of its actual terms. In the words of the Rockefeller Executive Committee, they are as follows: "(1) An institute of anatomy. (2) Increase of clinical facilities. (3) Clinical laboratories planned. (4) Increased maintenance costs. (5) Closely unified administration." The Medical School will receive 835,000*l.* and the College 370,000*l.* Further details of the ways in which it is proposed to utilise the money will be duly announced. At this meeting Prof. Elliot Smith pointed out that anatomy is to be understood as including in its purview the microscopic structure of the tissues, embryology, and a study of the factors governing the development of form. It is further to be hoped that the working of the scheme will involve a much closer co-operation between the College and the medical departments, to the advantage of both.

It is perhaps advisable to direct attention to the fact that the gift is for the purpose of improving medical education and research. At the same time the hospital, as an institution for the cure of patients, will benefit indirectly, although doubtless its working expenses will be increased owing to the enlargement proposed.

W. M. BAYLISS.

The Permanent Value of University Benefactions.

AN account of the opening of the new building of the Department of Applied Statistics and Eugenics at University College, London, presented by Sir Herbert Bartlett, was given in last week's NATURE. The speech made by Prof. Karl Pearson in seconding the vote of thanks to the donor contains certain truths which have a wider application than to the immediate audience, and we therefore reproduce it

in the hope that it will help to force the present difficult situation of the universities upon the attention of the public.

Henry VI., 1422–61. You probably all think of him as a weakling, the monarch whose forces were cleared out of the best part of France by Joan of Arc—a man naturally almost imbecile, and dominated by his Queen and a succession of dukes, and finally deposed by the victorious House of York. I feel otherwise towards him. For forty-five years I have worked under his image in a niche of my library. On my rare visits to Cambridge I would raise my hat to his statue on the front lawn of the college he founded. He may have been a poor King, but I owe the six most useful years of my life to the freedom his benefaction gave me to travel and to study. Despised as a King, there are many of us who respect our Royal benefactor as a scholar and a gentleman.

The spirit in which the members of old Cambridge colleges regard their founders and benefactors is one that should take deeper root in our new universities.

It is not merely the recognition of the name, but the insight that shall appreciate what the benefactor desired us to achieve, and the determination of successive generations that the purpose of the benefaction shall be carried out.

There are only too many ways of disposing of money! In 1441 it might be done by wars in France, by endowing monasteries to expedite the passage of your soul through purgatory, but those who founded or extended great centres of learning have remained in men's affection for all time. Nowadays you can dispose of your money to party funds or to charities; your name will survive just as long as your money is unspent or you have more to give. But the man who gives generously to a great academic institute will, if he chooses wisely, be certain of an ever-green memory.

In this institute we have had a number of benefactors, but three stand out for special mention on such an occasion as the present. The Worshipful Company of Drapers, who from 1903 onwards have assisted one section of our enterprise. Sir Francis Galton, who came of a family which has founded no fewer than three academic chairs, the Sedleian, the Savilian, and my own chair. Under his inspiration we work, and we are more than pleased to be better able to keep his memory fresh in our new buildings here than has been possible in the past in our cramped and temporary homes.

Lastly, we come to the benefactor whose benefaction is the subject of our gathering to-day. To him not only I, but every member of my staff feel daily gratitude for providing us with a more fitting, and, I will add, a more healthy environment, than we ever imagined would be ours, and I trust that the tradition will remain long after I have ceased to share the comfort of this building and the possibilities for the studious life it provides.

Those who have gone round this laboratory will have noted that we try to keep before us not only the portraits of great leaders of thought, but the portraits of the men who have made our work possible, and in this respect I should hope to be pardoned if I reminded Sir Herbert Bartlett of how deeply we should all appreciate the addition of such a memorial of his gift, so that we may have his form as well as his good works before us.

The war has left all academic enterprise stranded. In 1914 we could have equipped and fitted this building from basement to top story. Our contracts were rescinded, and for five years this laboratory was used as a military hospital. At present the fine buildings Sir Herbert Bartlett has provided lie to a large extent unoccupied. In 1871 the German nation made the extension of old and the founding of new universities a first claim on their war indemnities. In 1920 we hear no suggestion that from our universities a new national life has to spring, and that if they are to accomplish their task it can only be if the State and private friends come to their help in the present critical state of affairs. In this respect we can only trust that others will be as wise both for the present and for the future as Sir Herbert Bartlett has been. The winning of the war has been attributed in succession to many causes. One factor is rarely referred to, namely, the unselfish way in which the academic staff of university after university gave up their academic repose, broke through all their scholarly studies and their scientific researches, and, where they could not sacrifice their lives, at least sacrificed many of their best years of work for national service. Voluntary, and unpaid, and unpayable gifts for national welfare! It is absurd that the universities should have to prate of such labours; but here is the fact, regard it in what aspect you like, that with a greater task than ever before them, they are left with far less power to carry it out than they had before the war, and it is that knowledge which makes us the more deeply grateful to the special benefactor whom we wish to honour in this vote of thanks. He saw our necessity and responded to it.

The Imperial Entomological Conference.

THE Committee of the Imperial Bureau of Entomology may be congratulated on the success of the Entomological Conference which met on June 1–11 in the Linnean Society's rooms, Burlington House, London. The conference was attended by twenty official delegates representing most of the British Dominions, Colonies, and Protectorates, as well as by members of the committee of the Bureau, while a number of entomologists were invited to the meetings and discussions which occupied most of the appointed days. At the opening of the conference the delegates were received by Viscount Harcourt, chairman of the committee, and business meetings were held on the first and final days. On Friday, June 4, the conference visited the Rothamsted Agricultural Experiment Station in conjunction with a meeting of the Association of Economic Biologists; an account of this interesting day appeared in last week's NATURE (p. 464). On Tuesday, June 8, the members journeyed to Oxford, and on Thursday, June 10, to Cambridge. Prof. E. B. Poulton acted as host on the former, and Sir Arthur Shipley on the latter occasion. While the entomological collections in the University museums were the chief objects of interest, time was found for brief inspection of some features of the historic cities; for example, after entertaining the conference to lunch in Christ's College, Sir Arthur Shipley took the Overseas delegates into the rooms occupied ninety years ago by Charles Darwin.

Of the meetings held on the other five days of the conference it may be said that several subjects of much importance and of general interest were well and earnestly discussed. On the morning of June 2, under the presidency of Dr. R. Stewart MacDougall (Edinburgh), Mr. C. P. Lounsbury (Entomologist to the Union of South Africa) spoke on "Legislation in Regard to Plant Pests in the British Empire," insisting that the official entomologist should have authority to draft and enforce regulations against the introduction of plants which might harbour harmful insects; he advocated the drastic exclusion of such plants except in certain special cases, and expressed the opinion that little or no reliance can be placed on

certificates of freedom from pests—a view afterwards supported by several others who took part in the discussion. Mr. H. J. Elwes, however, remarked that a long experience in cultivation had convinced him that needless interference with freedom of import had sometimes been exercised by the authorities. On the chairman's suggestion, a sub-committee was appointed to consider the establishment of an Empire Convention on the subject.

"The Education of Economic Entomologists," the subject for discussion at the next morning meeting presided over by Prof. Poulton, was introduced by Prof. H. Maxwell Lefroy (Imperial College of Science). Prof. Lefroy advocated the establishment of entomology as a subject independent of general zoology, and, describing the courses in his own college, emphasised the necessity of a broad scientific training in physics, chemistry, and biology before the specialised entomological work could be profitably taken up; men with exceptional aptitude, however, might be admitted direct to advanced entomological study. The discussion was continued by Dr. R. J. Tillyard (Nelson, N.Z.), Dr. R. Stewart MacDougall (Edinburgh), Mr. F. Balfour Browne (Cambridge), Prof. R. Newstead (Liverpool), Prof. G. H. Carpenter (Royal College of Science, Dublin), Prof. R. D. Watt (Sydney, N.S.W.), and Mr. F. V. Theobald (Wye). While some doubt was expressed as to the advisability of divorcing entomology from general zoological study, there was general agreement as to the need of a sound and comprehensive scientific training, and several of the speakers insisted further that all entomologists in direct contact with cultivators ought to have practical knowledge of farm or garden work.

On Monday morning, June 7, Sir Daniel Morris in the chair, Mr. H. A. Ballou (Entomologist to the Department of Agriculture for the West Indies) opened a discussion on "The Resistance of Plants to Insect Attacks." He believed that in many cases perfectly healthy plants do not afford the best possible conditions for the life of sucking insects, while the food supply derived from weak or diseased plants may stimulate insects to abnormally quick growth and prolific reproduction. This view was supported by the infestation of thrips on cocoa-trees in the West Indies. Prof. R. D. Watt emphasised the possibility of finding strains of cultivated plants immune from insect attack, analogous to those now well known in certain cases as immune from fungus pests. Mr. C. C. Gowdey (Uganda) considered good cultural methods as of great importance in maintaining the resistant conditions.

A cognate subject, "Artificial *versus* Natural Methods of Control of Insect Pests," occupied the conference on Wednesday morning, June 9, when Prof. R. Newstead presided. Mr. F. W. Urich (Trinidad) opened the discussion with an account of various measures adopted in the West Indies, of which the distribution by means of spraying machines of fungus spores for the destruction of cercopids on sugar-cane was the most remarkable. Dr. Tillyard regarded spraying with insecticides as an imperfect palliative, and looked hopefully for results in poisoning aphids and scale-insects from the inoculation of trees with such substances as copper sulphate. Mr. F. Balfour Browne uttered a warning against the possible danger of introducing parasitic insects into new countries in order that they may prey upon previously introduced plant-feeding insects, but Prof. H. Maxwell Lefroy and Dr. A. D. Imms regarded any danger from this now-established practice as remote.

Several interesting papers on more special subjects were read. On the afternoon of Monday, June 7, Mr. G. E. Bodkin gave his experience of the insect pests of British Guiana, and dwelt on the difficulty of controlling sugar-cane insects because of their habits of migration. On the same occasion Mr. F. W. Urich described the insect pests of Trinidad, and Mr. H. A. Ballou contributed a general review of conditions in the West Indies. On the afternoon of June 9 Dr. MacDougall lectured on "Insects in Relation to Afforestation," with lantern illustrations, pointing out the bearing of the feeding habits of common British timber- and bark-beetles upon practical questions of forest management. A discussion involving the uniformity of habit among insects of the same species in all parts of its range was carried on by Mr. C. F. C. Beeson (India) and Dr. Munro (Board of Forestry); the latter expressed regret that the Scottish and English Scolytidæ follow the rules laid down in the classical German text-books of forest entomology. Mr. F. A. Stockdale (Ceylon) followed with an account of the insect pests of tea in that island. On the afternoon of Wednesday, June 2, when Sir David Prain took the chair, Mr. H. H. Ballou read a paper on "Cotton Pests," dwelling particularly on the boll weevil and the pink bollworm, the latter of which caused a loss of 10,000,000*l.* in Egypt in the year 1917. Cotton insects are controlled by destroying at the end of the season all material in the field in which the species might survive until the next season. Mr. H. H. King described the organisation of entomological work in the Anglo-Egyptian Sudan, and stated that nine field laboratories under the charge of trained entomologists would be necessary for the proper working of the area.

Of the special questions discussed the most noteworthy was the tsetse-fly problem, considered at the meeting on Saturday morning, June 5, appropriately presided over by Sir David Bruce. Several entomologists from Africa spoke, including Messrs. R. W. Jack (South Rhodesia), Dr. A. May (North Rhodesia), and Mr. Ll. Lloyd and Dr. G. D. H. Carpenter (Uganda). An experiment as to the effect on the fly of the clearance of "big game" from a district in Rhodesia is now being tried. The opinion was expressed that the result of this will be disappointing, as mammalian blood forms, as a rule, only a small proportion of the food-supply of Glossina. Dr. Carpenter informed the meeting of the success which had followed the erection of inclined screens, under which hundreds of puparia are found; this means of control was suggested by an observation of the large number of puparia present in the shelter of a blown-down tree.

The conference concluded on Friday, June 11, with a business meeting, at which several resolutions were passed; these may be briefly summarised. (1) A conference should be held in London every five years. (2) The Imperial Bureau of Entomology should be established permanently; the cessation or curtailment of its work would be deplorable. (3) The Governments contributing to the expenses of the Bureau should be urged to guarantee their contributions. (4) The funds at present contributed for the upkeep of the Bureau are inadequate; they should be increased so as to provide an income of at least 13,000*l.* a year. (5) The Colonial Secretary should be requested to establish a provident fund for the Bureau staff. (6) The director and committee of the Bureau should have full power to exercise their discretion as to the scope and contents of the publications and the expenditure involved. (7) The director should encourage members of the staff to pay attention to particular groups of insects, especially those for the identification of which no specialist is available. (8) The provision of an adequate number of trained men to carry into effect existing plant-import legislation is of more immediate importance than the revision or extension of such legislation.

Members of the conference had the privilege of attending meetings of the Linnean, Zoological, and Entomological Societies, as well as the Staff Conversazione at the Natural History Museum. These gatherings, in addition to the three whole-day excursions to Rothamsted, Oxford, and Cambridge, gave welcome opportunity for informal discussion and pleasant social intercourse. Much gratification was felt and expressed at the presence for the first two days of Dr. L. O. Howard, Entomologist of the U.S. Department of Agriculture. His brief, pointed remarks at some of the discussions were much appreciated; he deplored some recent attempts to destroy "entomology" as a specific economic subject by dividing its subject-matter between "parasitology" and "phytopathology." All who participated in the conference appreciated the untiring efforts of Dr. G. A. K. Marshall and Dr. S. A. Neave, of the Imperial Bureau, who before and during the meetings did their utmost for the success of the gathering.

On the evening of the closing day the members of the conference were entertained to dinner at Lancaster House by H.M. Government, Viscount Harcourt presiding. Thus was pleasantly and fittingly demonstrated the increasing recognition of the importance of the study and practice of science in relation to the interests and industries of the Empire.

G. H. C.

The Selous Memorial at the Natural History Museum.

THE movement started in 1917 to perpetuate the memory of the late Capt. F. C. Selous, D.S.O., by a national memorial achieved its aim on Thursday, June 10, when Mr. Edward North Buxton, vice-chairman of the Memorial Committee, himself a great hunter in his day, in the unavoidable absence of the chairman, the Right Hon. E. S. Montagu, M.P., unveiled at the Natural History Museum, South Kensington, a bronze bust of Selous—the work of Mr. W. R. Colton, R.A.—before a distinguished and representative gathering.

The bust is mounted in a niche of grey granite from the Matoppo Hills, the burial-place of Cecil Rhodes and Sir Starr Jameson, and is the gift of the Union Government of South Africa. It was brought to this country by the Union Castle Line free of all charges. Below the bust is a bas-relief, also in bronze, depicting a lion and lioness, and in the distance an elephant, a situtunga, and other big-game animals, symbolical of the interests of the great sportsman and explorer. The granite bears the inscription: "Captain Frederick C. Selous, D.S.O., hunter, explorer, and naturalist. Born 1853. Killed in action at Beho-Beho, German East Africa, 4. i. 1917."

Mr. Buxton in his speech referred to the qualities of Selous which had endeared him to so many friends, and summarised these when he said that "Selous was a great hunter, and a still greater gentleman." On behalf of the committee he asked Viscount Grey of Fallodon, K.G., and the other trustees of the museum to accept the memorial and to preserve it in the museum for all posterity.

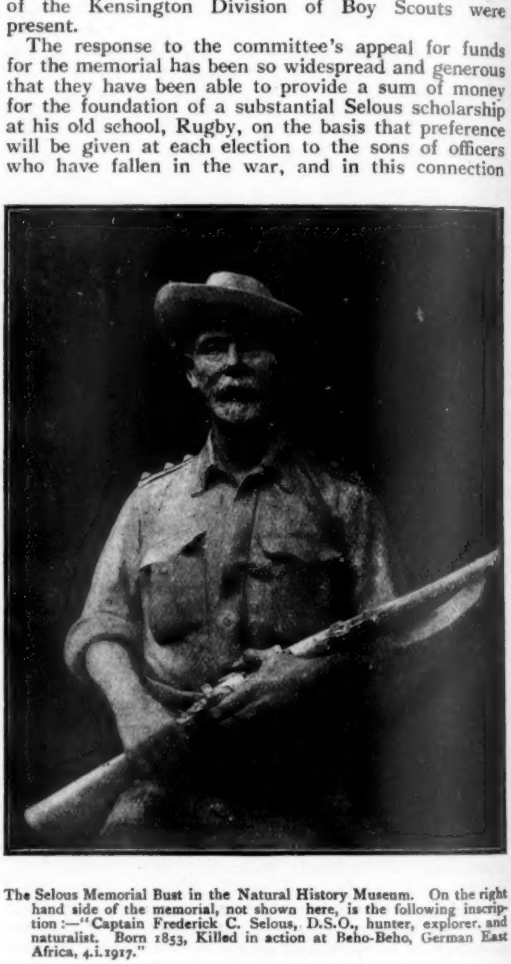
In his reply Lord Grey stated that in the museum, which was a national institution, this national memorial would be kept and honoured as a memorial to one who was a great explorer, a great traveller, a great hunter, and, besides that, a most brave and single-minded and attractive character.

The King sent a message to the effect that he felt that no more appropriate place than the Natural History Museum could be selected for a memorial to Capt. F. C. Selous.

It is indeed in the fitness of things that this memorial should have found a permanent place in the museum; for, next to his own home, there was no place in England which more attracted Selous than the museum, and when he was in this country he seldom kept away from it for more than a week; sometimes he was a daily visitor.

A guard of honour composed of officers and men of the Legion of Frontiersmen, many of whom had served with Selous in East Africa, and a detachment of the Kensington Division of Boy Scouts were present.

The response to the committee's appeal for funds for the memorial has been so widespread and generous that they have been able to provide a sum of money for the foundation of a substantial Selous scholarship at his old school, Rugby, on the basis that preference will be given at each election to the sons of officers who have fallen in the war, and in this connection



The Selous Memorial Bust in the Natural History Museum. On the right hand side of the memorial, not shown here, is the following inscription:—"Captain Frederick C. Selous, D.S.O., hunter, explorer, and naturalist. Born 1853, Killed in action at Beho-Beho, German East Africa, 4.i.1917."

it is with special satisfaction that we learn that in the examination for the scholarship a love and knowledge of natural history on the part of the candidate will be the deciding factor.

A few words may be said respecting Mrs. Selous's gift to the nation of her husband's splendid collection of big-game trophies and of birds' eggs, a gift for which Viscount Grey, on behalf of the trustees, conveyed to the donor his warm thanks, and at the same time expressed his high appreciation of its value and importance.

The collections have now been received at the Natural History Museum, and the big-game specimens are in course of being catalogued by Mr. Guy Dollman. We understand that it is the intention of the trustees to publish this catalogue, a work which cannot fail

to be of abiding interest to naturalists and sportsmen. The collection consists of 550 specimens—the greater part from South and East Africa—of splendid heads. It also includes nineteen magnificent lion-skins and a skull of the South African white rhinoceros—an extinct species—with exceptionally fine horns.

The collection of birds' eggs consists of 7010 specimens obtained in Great Britain, Europe, and Asia Minor. The great feature of the collection is that Capt. Selous personally took every egg from the nest himself. He would never accept any egg or clutch of eggs offered to him by a friend, nor would he purchase one from a dealer.

At the summons of a friend announcing the discovery of some rare bird's nest he would often travel very long distances, *e.g.* from one end of the British Isles to the other, in order that he might personally identify the parent birds and personally take the eggs from the nest. For this reason, no less than for the amazing neatness and methodical care with which it was arranged, to say nothing of its comprehensive range, the collection is a particularly valuable one.

University and Educational Intelligence.

BIRMINGHAM.—On the advice of Sir John Cadman, whose appointment as a technical adviser to the Government on matters relating to coal and petroleum is announced, the department of mining is to be reorganised and extended. In addition to the new professor of mining there is to be an assistant-professor of petroleum technology. It is hoped that Sir John Cadman will still retain some connection with the faculty of science.

Prof. F. W. Burstall has been elected dean of the faculty of science, to succeed Sir John Cadman.

CAMBRIDGE.—As briefly announced last week, a scheme for endowing a school of biochemistry has been approved by the High Court of Justice, and has now been submitted to the University by Sir Jeremiah Colman, Bart., on behalf of the trustees of the late Sir William Dunn, Bart. The residuary estate of Sir William Dunn was left in trust for certain charitable purposes, including the alleviation of human suffering. The trustees propose, with that object in view, to encourage and endow with the substantial sum of 160,000*l.* the study of biochemistry, one of the fundamental sciences of medicine, the progress of which is essential to the advance of medical knowledge. Having regard to the fact that the study of biochemistry in this country had its first beginnings in Cambridge, and is at present being carried on there without endowment under Prof. Gowland Hopkins, the trustees offer the University 165,000*l.* to found the Sir William Dunn School of Biochemistry. Of this sum they allot 25,000*l.* to endow a professorship and 10,000*l.* to endow a readership in biochemistry, the balance to be used in erecting and equipping an institute of biochemistry and in providing funds for its maintenance and upkeep and an endowment for research work.

This munificent benefaction is a most pleasing tribute to the work of Prof. Hopkins and his colleagues.

Dr. T. G. Adami, Vice-Chancellor of Liverpool University, has been elected honorary fellow of Jesus College.

Mr. J. E. Littlewood, Trinity College, has been appointed Cayley lecturer in mathematics, and Mr. J. H. Grace, Peterhouse, has been re-appointed University lecturer in mathematics.

The Special Board for Mathematics has recommended the substitution of thermodynamics for elementary optics in Schedule A of Part II. of the Mathematical Tripos.

In connection with the coming meeting of the British Medical Association at Cambridge, honorary degrees are proposed for the Master of Pembroke, Sir T. Clifford Allbutt, Jules Bordet, A. Calmette, H. Cushing, S. Flexner, Piero Giacosa, Major-Gen. Gorgas, Sir George Makins, Sir Patrick Manson, and Sir Norman Moore.

LIVERPOOL.—The council of the University has appointed Mr. T. R. Wilton as lecturer in dock and harbour engineering, with the title of associate-professor. Mr. Wilton is closely connected with the Liverpool Engineering Society, and has done valuable work for that body as hon. secretary—a position he has held since 1907. He has been for some years special lecturer in dock and harbour construction at the University, has carried out important investigations on the movement of sand and currents, and has also taken observations of a practical nature on the Mersey.

MR. H. RICHARDSON, of the Municipal College of Technology, Manchester, has been appointed principal of the Bradford Technical College in succession to Prof. W. M. Gardner.

THE Ministry of Agriculture and Fisheries is open to receive until July 15 nominations for a limited number of research scholarships in agricultural science, each tenable for two years, and of the annual value of 200*l.* Candidates must be graduates with honours in science of British universities, with evidence of high proficiency in subjects having a direct bearing on agriculture, and be nominated by a professor or lecturer of a university or college. Nomination forms are obtainable from the General Secretary of the Ministry, 72 Victoria Street, S.W.1.

THE *Library Association Record* for May contains a paper on "Technical Libraries and Intelligence" by Major W. E. Simnet, and also an article on "The Technical Library" by Mr. R. Borlase Matthews. Mr. Matthews lays stress on the necessity for making the most recent publications immediately available for reference, and discusses the various ways in which a technical library can be made accessible to readers. Major Simnet, taking the subject of engineering as an example, points out that there are at present in London several libraries containing books and periodicals relating to engineering, and that this involves much overlapping which might be avoided by amalgamation. He also refers to the Transport Library to be formed by the Ministry of Transport. Such a library would be devoted to all aspects and methods of transportation. The importance of an index of technical literature, possibly on the lines of the International Catalogue of Scientific Literature, is carefully explained by Major Simnet, who recommends a combination of indexing and abstracting. At the same time he finds that papers on technical subjects become out of date much sooner than papers on purely scientific topics, so that it is less necessary to preserve all titles of technical papers in a permanent index. Major Simnet gives an account of the *Technical Review*, established since the armistice to continue the work of the *Technical Supplement*, published in 1918 under the auspices of the War Office. As a further contribution to the indexing of technology, the *Library Association Record* for May, 1920, contains a subject-index to papers published in 1917–19 on fuel, including gas and petroleum. The list is prepared by the editors of the "Subject Index of Periodicals," and is an example of the thoroughness which their work always exhibits.

ONE of the problems at present confronting the Ministry of Agriculture is the provision of advice and supervision for the smallholder. This problem has become more acute now that so many of the men settling on the land are lacking, either partly or altogether, in knowledge of the theory and practice of horticulture. When the question arose of appointing organisers to instruct these men and to look after their interests, it was found that the number of candidates qualified to fill such posts was extremely limited. A man who is to organise the horticultural instruction of a county should have a knowledge of the scientific side of the subject as well as of its practical side. Quite apart from this question of supplying instruction for smallholders, it is obviously desirable, in view of the rapidly increasing importance of horticulture in this country, that the prospective fruit-farmer or market-gardener should be able to obtain instruction in his subject as scientific and comprehensive as that which can be so readily obtained nowadays by the prospective agriculturist. In order that such instruction may be available, the Ministry of Agriculture has made it possible for the University of Cambridge to establish a degree in horticulture and a post-graduate diploma. The course for the degree will extend over three years, and will consist of instruction in the theory and practice of commercial fruit- and vegetable-growing, the practical side of the subject being treated no less fully than its theoretical aspect. It is hoped that the course for the diploma will provide men qualified for research work in horticulture. Hitherto there has been a dearth of such men owing to difficulty in obtaining suitable training, and research work in connection with an important industry has therefore been greatly hampered. The courses will commence in October next, and information concerning them can be obtained from the Secretary, School of Agriculture, Cambridge.

Societies and Academies.

LONDON.

Zoological Society, June 1.—Sir Sidney F. Harmer, vice-president, in the chair.—Dr. G. M. **Vevers**: Report on the Entozoa collected from animals which had died in the society's menagerie during the past nine months.—Dr. W. T. **Calman**: Notes on marine wood-boring animals. I.: The shipworms (Teredinidæ).

CAMBRIDGE.

Philosophical Society, May 17.—Mr. C. T. R. Wilson, president, in the chair.—Dr. F. W. **Aston**: The atomic nature of matter in the light of modern physics.

MANCHESTER.

Literary and Philosophical Society, May 18.—Mr. R. L. Taylor, vice-president, in the chair.—W. **Thomson** and H. S. **Newman**: Further notes on the filamentous growths from aluminium amalgams. Experiments to determine the ratio of the mercury to 100 parts of alumina were detailed, and descriptions of erratic growths given. The action of mercury on zinc was compared with its action on aluminium.—Prof. Sydney **Chapman**: The effects of lunar tides on the earth's atmosphere. The barometric pressure shows a very minute tidal variation with the period of half a lunar day. This variation can be determined only by a difficult process of averaging out other regular and irregular variations from long series of hourly barometric observations, so that data from very few stations are available. The author described and discussed their theoretical significance. Many questions suggested by the data have as yet received no satisfactory answer, but their elucidation, as further data accumulate, should add to our knowledge of the atmosphere in some important respects.—Dr. R. S. **Willows**: Transverse section of cotton fibre illustrating Balls's daily growth rings.

PARIS.

Academy of Sciences, May 31.—M. Henri Deslandres in the chair.—G. A. **Boulenger**: Remarks on the note of M. Ad. Davy de Virville concerning the species *Primula elatior, acaulis,* and *officinalis*.—Ch. **Gautier**: A sundial giving legal time throughout the year with a sufficient approximation for ordinary purposes, as well as the approximate date. The dial described and illustrated gives the legal time within about one minute. At the equinoxes it gives the exact date, but at the solstices only an approximation to the date.—Alex. **Véronnet**: The equilibrium figures of a liquid in rotation. Order of succession of the critical figures of bifurcation.—M. T. **Huber**: The generalisation of a theorem of M. Mesnager concerning the sense of the displacements of a rectangular plate.—J. **Fallou**: The expansion caused by Joule's effect at the contact of two solids. Two metals in contact when heated electrically expand proportionally to the square of the current or to the heat developed by the Joule effect.—A. **Guillet**: An auto-ballistic astronomical pendulum. An attempt to realise the conditions laid down by G. Lippmann and B. Baillaud, the impulses being supplied by induced currents.—M. **Girousse**: The calculation of currents causing electrolysis in metallic masses near an electric traction line.—F. **Vlès**: Contribution to the study of absorption based on the properties of the nitrophenols. By the application of formulæ given in a previous communication it is shown how the absorption spectrum of a compound can be calculated from its composition.—F. **Bourion**: Kinetic study of the chlorination of benzene. The effects of rate of supply of chlorine, concentration of the benzene in chlorobenzene, and of temperature upon the reaction velocity were examined separately.—L. **Vignon**: The resistance of tissues to light and ultra-violet rays. Linen and silk tissues were exposed to sunlight and to ultra-violet rays (Heraeüs quartz lamp) under dry and moist conditions, and the changes in the strength, as measured by the breaking load, determined. The silk fabric showed greater resistance than the linen to the effects of exposure.—E. E. **Blaise**: The action of hydrazine on the 1:4 acyclic diketones. Details are given of the products of the reactions between hydrazine and acetonylacetone and hydrazine and dipropionylethane.—A. **Gascard**: Ceryl alcohol and cerotic acid from China wax. The wax, after a preliminary purification, was saponified by potash in alcohol-benzene solution, the cerotic acid precipitated as calcium salt, and the ceryl alcohol recovered from the filtrate. Brodie's formula for the alcohol was confirmed by preparation and analysis of ceryl iodide, $C_{26}H_{53}I$, and for cerotic acid by oxidation of the alcohol and by its acidity figure.—A. **Guilliermond**: Observations on the living chondriome of one of the Saprolegniaceæ.—L. **Daniel**: A new race of Asphodelus obtained by the action of a marine climate. A description of the changes in type produced in *Asphodelus luteus* by twenty years' cultivation on the sea-coast. The modified plant can not only be reproduced by subdivision of the roots, but also by growing from seed.—P. **Ammann**: The great richness in nitrogenous matter of certain maniocs from Cambodge.—A. **Chevalier**: Researches on pear-trees, walnuts, and chestnuts of the cooler parts of Indo-China and the south of China.—E. **Foëx**: Necrosis of the stem of the potato attacked by the

disease potato leaf-roll.—P. **Portier**: Regeneration of the testicle in the pigeon deprived of vitamines.—A. C. **Hollande**: Œnocytoids and teracytes in the blood of caterpillars.—E. **Fauré-Fremiet**: The action of different chemical compounds on the pulmonary epithelial cell.—A. **Mayer**, H. **Magne**, and L. **Plantefol**: Reflex action produced by the irritation of the deeper respiratory tracts. The antagonism of this reflex with that caused by the irritation of the upper respiratory passages.—G. **Bertrand** and Mme. **Rosenblatt**: The action of chloropicrin upon yeast and *Saccharomyces vini*. A concentration of 1 milligram of chloropicrin per litre is sufficient to slow down fermentation by yeast, and 5 to 6 milligrams per litre completely arrests the production of alcohol. *Saccharomyces vini* is even more sensitive, growth being stopped by 1 milligram of chloropicrin per litre.

CAPE TOWN.

Royal Society of South Africa, April 21.—Dr. J. D. F. Gilchrist, president, in the chair.—L. **Péringuey**: Note on the whales frequenting South African waters. The author describes the various whales which are known to frequent the coasts of South Africa. The number of these is still under discussion. The fact is now well established that certain Northern whales are specifically identical with the Southern whales, and are the kinds of whales found on the South African coasts. That they are migrants, perhaps with the exception of *Balaenoptera Brydei*, is a well-established fact, but what is probably less known is that the animals go to warmer equatorial waters to breed or calve. If they are intercepted on their way there from the Antarctic or on their return the multiplication of the species will be greatly hindered, to say the least. People interested in the whaling industry admit that some measure of protection is necessary.—J. R. **Sutton**: Overgrowths on diamond. In this paper the author discusses in detail overgrowths of calcite, bort of various kinds, graphite, and diamond on diamond. Experiments were made with the object of determining why certain diamonds from yellow ground are not separated from the concentrates on the grease tables, the conclusion being reached that carbonate of lime readily forms a coating on a diamond surface, causing the diamond to behave like a common mineral in the pulsator gravel. A clear diamond is readily wetted by a solution of carbonate of soda, but not by pure water. Overgrowths of graphite and of black bort are common, and define per saltum stages of crystallisation. Thirteen specimens of "hailstone" structure are described. Laminated diamonds appear to be examples of overgrowth of diamond on diamond with interposing planes of colouring matter.—J. R. **Sutton**: Some statistics of thunder and lightning at Kimberley. The author gives tables of the results of eye and ear observations of thunder and lightning made at Kimberley during the twenty-three years 1897 to 1919, and classifies the storms according to the classification given by Ley. A phenomenon of interest is the "smell" of a thunderstorm. The author observed this only once strongly in Kimberley. European meteorological literature of the seventeenth and eighteenth centuries has many allusions to the "sulphureous smell" of lightning.—S. H. **Skaife**: Notes on some South African Entomophthoraceæ. The material used by the author was collected at Cedara, Natal, in 1919 and 1920. The great majority of the family are parasitic on insects. The author describes and figures South African species of Entomophthoraceæ and his experiments of cultivating them from dead and dying flies and grasshoppers and of infecting insects from the cultures.

Books Received.

Banff and District. By A. E. Mahood. Edited by Dr. E. I. Spriggs. Pp. xvi+388. (Banff: Banffshire Journal, Ltd.)

The Glow-worm and Other Beetles. By J. H. Fabre. Translated by A. T. de Mattos. Pp. viii+488. (London: Hodder and Stoughton, Ltd.) 8*s*. 6*d*. net.

A Geographical Bibliography of British Ornithology from the Earliest Times to the End of 1918. By W. H. Mullens, H. Kirke Swann, and Rev. F. C. R. Jourdain. Part 4. Pp. 289–384. (London: Witherby and Co.) 6*s*. net.

The Ascent of Man. Pp. 74. (London: The Horniman Museum.) 6*d*.

Airplane Photography. By Major H. E. Ives, U.S. Army. Pp. 422. (Philadelphia and London: J. B. Lippincott Co.) 18*s*. net.

The Nation's Food: A Statistical Study of a Physiological and Social Problem. By Prof. Raymond Pearl. Pp. 274. (Philadelphia and London: W. B. Saunders Co.) 16*s*. net.

Co-Education and its Part in a Complete Education. By J. H. Badley. Pp. 39. (Cambridge: W. Heffer and Sons, Ltd.) 2*s*. net.

The Year-Book of the Scientific and Learned Societies of Great Britain and Ireland. Thirty-sixth Annual Issue. Pp. vii+336. (London: C. Griffin and Co., Ltd.) 12*s*. 6*d*. net.

The Organisation of Industrial Scientific Research. By Dr. C. E. Kenneth Mees. Pp. ix+175. (New York and London: McGraw-Hill Book Co., Inc.) 12*s*.

Memoirs of the Geological Survey, Scotland: The Economic Geology of the Central Coalfield of Scotland. Description of Area VII. By the late Dr. C. T. Clough and others. Pp. vii+144. (Edinburgh: H.M.S.O.) 7*s*. 6*d*. net.

Memoirs of the Geological Survey. Special Reports on the Mineral Resources of Great Britain. Vol. vi. Second edition. Pp. vi+241. (London: H.M.S.O.) 7*s*. 6*d*. net.

Contributions from the Jefferson Physical Laboratory and from the Cruft High-tension Electrical Laboratory of Harvard University for the Years 1916, 1917, and 1918. Vol. xiii. (Cambridge, Mass.)

A Naturalist on the Amazons. By H. W. Bates. Abridged and edited for schools by Dr. F. A. Bruton. Pp. xix+182. (London: Macmillan and Co., Ltd.) 2*s*. 6*d*.

Tables of the Motion of the Moon. By Prof. E. W. Brown, with the assistance of H. B. Hedrick. Sections i. and ii. Pp. xiii+140+39. Section iii. Pp. 223. Sections iv., v., and vi. Pp. 99+56+102. (New Haven, Conn.: Yale University Press; London: Oxford University Press.) 4 guineas net.

Outlines of the Geology of Brazil, to accompany the Geologic Map of Brazil. By J. C. Branner. Second edition. Pp. 189–338+plates. (N.Y. City: Geological Society of America.) 3.35 dollars.

War against Tropical Disease. By Dr. A. Balfour. Pp. 219. (London: Baillière, Tindall, and Cox.) 12*s*. 6*d*. net.

The New Psychology and its Relation to Life. By A. G. Tansley. Pp. 283. (London: George Allen and Unwin, Ltd.) 10*s*. 6*d*. net.

A Guide to the Old Observatories at Delhi, Jaipur, Ujjain, Benares. By G. R. Kaye. Pp. vii+108+xv plates. (Calcutta: Supt. Govt. Printing, India.) 3*s*. 6*d*.

A Guide to the Identification of our more Useful Timbers. By H. Stone. Pp. viii+52+3 plates. (Cambridge: At the University Press.) 7*s*. 6*d*. net.

Elgie's Weather Book: For the General Reader. By J. H. Elgie. Pp. xii+251. (London: The Wireless Press, Ltd.) 5s. net.

Structural and Field Geology. By Dr. J. Geikie. Fourth edition. Pp. xxiv+454+lxix plates. (Edinburgh: Oliver and Boyd; London: Gurney and Jackson.) 24s. net.

The Evolution of a Coast-Line: Barrow to Aberystwyth and the Isle of Man, with Notes on Lost Towns, Submarine Discoveries, etc. By W. Ashton. Pp. xvi+302. (London: Edward Stanford, Ltd.) 10s. net.

Allgemeine Erkenntnislehre. By M. Schlick. Pp. x+346. (Berlin: J. Springer.) 18 marks.

Letters of Travel. By Rudyard Kipling. Pp. vi+284. (London: Macmillan and Co., Ltd.) 7s. 6d. net.

The Revels of Orsera: A Mediæval Romance. By Sir Ronald Ross. Pp. vi+393. (London: John Murray.) 7s. net.

The Group Mind. By W. McDougall. Pp. xvi+304. (London: Cambridge University Press.) 21s. net.

Malaria at Home and Abroad. By Dr. S. P. James. Pp. xi+234. (London: John Bale, Ltd.) 25s. net.

The End of the World. By J. McCabe. Pp. vii+267. (London: G. Routledge and Sons, Ltd.) 6s. net.

Pharmacology. By Dr. D. Cow. Pp. viii+132. (London: J. and A. Churchill.) 7s. 6d. net.

Oil-Finding. By E. H. Cunningham Craig. Second edition. Pp. xi+324+xiii plates. (London: Edward Arnold.) 16s. net.

Forest Management. By Prof. A. B. Recknagel and Prof. J. Bentley, Jr. Pp. xiii+269+iii plates. (New York: J. Wiley and Sons, Inc.; London: Chapman and Hall, Ltd.) 13s. 6d. net.

Aeronautics. By Prof. E. B. Wilson. Pp. vii+265. (New York: J. Wiley and Sons, Inc.; London: Chapman and Hall, Ltd.) 22s. net.

Diary of Societies.

THURSDAY, JUNE 17.

ROYAL SOCIETY, at 4.30.—Prof. W. Bateson: Genetic Segregation (Croonian Lecture).

LINNEAN SOCIETY, at 5.—Celebration of the Centenary of Sir Joseph Banks, Bart. (1743–1820).—Dr. B. Daydon Jackson: Banks as a Traveller.—Dr. A. B. Rendle: Banks as a Patron of Science.—J. Britten: Banks as a Botanist.

ROYAL COLLEGE OF PHYSICIANS OF LONDON, at 5.—Dr. A. F. Hurst: The Psychology of the Special Senses and their Hysterical Disorders (Croonian Lecture).

ROYAL SOCIETY OF MEDICINE (Dermatology Section), at 5.

CHEMICAL SOCIETY (at Institution of Mechanical Engineers), at 8.—Prof. J. C. McLennan: Helium.

HARVEIAN SOCIETY OF LONDON (at Medical Society), at 8.30.—Dr. E. G. Little: Differential Diagnosis of some Common Skin Eruptions.

SOCIETY OF ANTIQUARIES, at 8.30.

FRIDAY, JUNE 18.

INSTITUTION OF SANITARY ENGINEERS (at Holborn Restaurant), at 11.30 a.m.—The President: The Institution and its Future.—A. J. Martin: Sanitary Socialism. At 2.30.—T. Robertson: Poured Concrete Construction.—G. W. Chilvers: Health, Wealth, and Housing.—A. P. I. Cotterell: A Glimpse at Domestic Engineering in some of the Eastern States of America.

ROYAL SOCIETY OF ARTS (Indian Section), at 4.30.—Sir Valentine Chirol: The Enduring Power of Hinduism (Sir George Birdwood Memorial Lecture).

GEOPHYSICAL COMMITTEE (at Royal Astronomical Society), at 5.—Commander H. D. Warburg, Prof. H. Lamb, Dr. J. Proudman, Dr. A. T. Doodson, Major A. J. Wolff, and H. L. P. Jolly: Discussion on Tides.

SOCIETY OF TROPICAL MEDICINE AND HYGIENE (Annual General Meeting), at 8.30.—Dr. F. H. Stewart: Recent Work on Round-worm Infection.

SATURDAY, JUNE 19.

BRITISH PSYCHOLOGICAL SOCIETY (at University College, Gower Street), at 3.30.—Dr. J. Drever: The Emotional Phases of Affective Experience.

PHYSIOLOGICAL SOCIETY (at Physiological Laboratory, University of London, South Kensington), at 4.30.—G. Aurep and C. Lovatt Evans: The Mode of Action of Vaso-dilator Nerves.—C. Lovatt Evans: The Lactic Acid Content of Plain Muscle.

MONDAY, JUNE 21.

ROYAL GEOGRAPHICAL SOCIETY (at Æolian Hall), at 8.30.—Major L. F. I. Athill: Through South-west Abyssinia to the Nile.

ROYAL INSTITUTE OF BRITISH ARCHITECTS, at 8.30.

ARISTOTELIAN SOCIETY (at 74 Grosvenor Street), at 8.—Miss Beatrice Edgell: Memory and Conation.

TUESDAY, JUNE 22.

ROYAL COLLEGE OF PHYSICIANS OF LONDON, at 5.—Dr. A. F. Hurst: The Psychology of the Special Senses and their Hysterical Disorders (Croonian Lecture).

ROYAL AERONAUTICAL SOCIETY (at Central Hall, Westminster), at 8.30.—Comdr. J. C. Hunsaker: Naval Architecture in Aeronautics (Wilbur Wright Lecture).

WEDNESDAY JUNE 23.

GEOLOGICAL SOCIETY OF LONDON, at 5.30.—O. Holtedahl: The Scandinavian "Mountain Problem."

INSTITUTION OF ELECTRICAL ENGINEERS (Wireless Section), (at Institution of Mechanical Engineers), at 6.—B. S. Gossling: The Development of Thermionic Valves for Naval Uses.

THURSDAY, JUNE 24.

ROYAL SOCIETY, at 4.30.—*Probable Papers.*—Sir Ray Lankester: Some Rostro-carinate Flint Implements and Allied Forms.—Lord Rayleigh: A Re-examination of the Light scattered by Gases in respect of Polarisation. I. Experiments on the Common Gases.—A. Mallock: Note on the Influence of Temperature on the Rigidity of Metals.—Drs. E. F. Armstrong and T. P. Hilditch: A Study of Catalytic Actions at Solid Surfaces. V. The Rate of Change conditioned by a Nickel Catalyst and its Bearing on the Law of Mass Action.—Dr. H. Jeffreys: Tidal Friction in Shallow Seas.—Other Papers.

LINNEAN SOCIETY OF LONDON, at 5.—Dr. C. J. F. Skottsberg: Recent Researches on the Antarctic Flora.—Dr. R. J. Tillyard: The Cawthorn Institute, New Zealand, and its Biological Function.

OIL AND COLOUR CHEMISTS' ASSOCIATION (at Food Reform Club, 2, Furnival Street), at 7.30.—A. E. Bawtill: (1) A Hydrometer for Accurate Determinations of Pastes and Viscous Materials; (2 A Viscometer which Combines Increased Efficiency with the Power of Measuring "Stickiness" Independently of Viscosity.

FRIDAY, JUNE 25.

PHYSICAL SOCIETY OF LONDON, at 5.—Dr. J. H. Vincent: The Origin of the Elements.—W. H. Wilson and Miss T. D. Epps: The Construction of Thermo-couples by Electro-deposition.—J. Guild: The Use of Vacuum Arcs for Interferometry.—S. Butterworth: The Maintenance of a Vibrating System by Means of a Triode Valve.

CONTENTS.

	PAGE
University Stipends and Pensions	477
Aerography	479
Paper-making and its Machinery. By R. W. Sindall	480
The Structure of the Nucleus. By R. R. G.	482
Our Bookshelf	483
Letters to the Editor:—	
London University Site and Needs.—Sir E. Sharpey Schafer, F.R.S.	484
High Rates of Ascent of Pilot-Balloons. (*With Diagram.*)—Dr. W. van Bemmelin	485
A New Method for Approximate Evaluation of Definite Integrals between Finite Limits.—Commander Thos. Y. Baker	486
The Royal Military Academy.—J. Young	486
The Separation of the Isotopes of Chlorine.—D. L. Chapman, F.R.S.	487
A Note on Telephotography.—A. B.	488
Recent Researches on Nebulæ. (*Illustrated.*) By Major William J. S. Lockyer	489
The Importance of Meteorology in Gunnery. By Dr. E. M. Wedderburn	492
Obituary:—	
S. Ramanujan, F.R.S.—Prof. G. H. Hardy, F.R.S.	494
Principal Sir John Herkless, D.D., LL.D.	495
Notes	496
Our Astronomical Column:—	
The Masses of the Stars	500
The Planet Jupiter	500
Parallax Work at the Sproul Observatory	500
The Nuclear Constitution of Atoms. By Sir Ernest Rutherford, F.R.S.	500
The Rockefeller Gift to Medical Science. By Prof. W. M. Bayliss, F.R.S.	501
The Permanent Value of University Benefactions	501
The Imperial Entomological Conference. By G. H. C.	502
The Selous Memorial at the Natural History Museum. (*Illustrated.*)	504
University and Educational Intelligence	505
Societies and Academies	506
Books Received	507
Diary of Societies	508